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Striving for Change: Video-Based Teacher Education Programmes and Related Research

Guest editors
Tomáš Janík
Eva Minaříková
Alexander Gröschner

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Reports

Striving for Change: Video-Based Teacher Education Programmes and Related Research

It is indisputable that teaching is a demanding profession and that classroom situations place great demands on teachers, their professional knowledge, vision, and action. Teacher educators, both within the pre-service teacher education and in-service professional development, have always been striving to prepare teachers to be able to meet these demands. Innumerable university programmes, individual courses and lectures have been devised as well as many special intervention programmes. It is a current trend in teacher education to make use of video sequences of classroom situations to fulfil the above stated aim (Gaudin & Chaliès, 2015).

The use of video in teacher education is not new. As Sherin (2004) noted we can find examples of courses that made use of video already in the 1960s. Ever since then the use of video has become more and more accessible, affordable, user-friendly and thus more and more commonplace in teacher education programmes. The practice of using video went hand in hand with research on the topic. Numerous papers have been written, talks held and books published that aimed to shed light on the affordances of video that facilitate teacher learning, and on the effects of video-based interventions on teachers' professional knowledge, vision, actions etc. (e.g. Brophy, 2004; Calandra & Rich, 2014; Janik & Seidel, 2009). This special issue of *Orbis scholae* aims to continue this trend. It comprises six papers that report on the use of video in teacher education and a comment that asks what video-based reflection makes effective.

The first study, by *Ann-Kathrin Schindler*, *Alexander Gröschner* and *Tina Seidel*, reports on a video-based professional development programme that focused on classroom dialogue. It provides an account of a case study of one of its participants and the use of classroom dialogue in her teaching. The use of video is not connected only to the changes in the teacher's practice, but also to her students' engagement. Thus, a link between effects on teaching and on students' behaviour in the classroom is made.

The second paper, by *Eric Berson*, *Hilda Borko*, *Susan Million*, *Edit Khachatryan* and *Kerri Glennon*, focuses on a professional development programme that included not only theoretical input but also a practicum period where the teachers could use the newly acquired pedagogical strategies in a low stakes classroom context (outside their own schools). This practicum was accompanied by daily discussions in which video sequences were used to facilitate reflection. The study looked at how the strategies emphasized during the theoretical input were applied in the participants' teaching, thus again investigating the connection between the use of video in teacher education courses and the actual teaching practice.

The next two studies emphasized teachers' ability to notice and professional vision and both focus on subject-specific aspects of teaching. *Eva Minaříková*, *Michaela Píšová*, *Tomáš Janík* and *Klára Uličná* report on a professional development programme for teachers of English as a foreign language. During video club meetings, the concept of communicative competence as the ultimate goal of language learning and teaching was discussed. The study investigated whether these meetings influenced what teachers commented on when watching classroom videos.

From a mathematics teaching context, *Naďa Vondrová* and *Jana Žalská* worked in their study with pre-service teachers participating in Master's programme. They investigated what mathematics specific phenomena the students notice when observing classroom videos and whether this is different for students at the beginning and at the end of their studies. In this specific Master's programme, the subject-specific didactics courses make use of classroom videos and the authors draw conclusions about how videos can be used in order to help pre-service teachers focus on relevant mathematics specific phenomena.

The last two studies also pertain to pre-service teacher education. In their study, *Sonja Mohr* and *Rosella Santagata* acknowledge that it is not only teachers' knowledge that influences their decision making and classroom behaviour but also their beliefs. As the authors work with prospective mathematics teachers, they set out to explore the possibilities of influencing their beliefs through the use of video incorporated into the methods course.

Kathrin Krammer, *Isabelle Hugener*, *Manuela Frommelt*, *Gabriela Fürrer Auf der Maur* and *Sandro Biaggi* investigate the suitability of the use of own versus other teacher's video in pre-service teacher education. The study did not focus on the benefits of these two variations as such but on whether the students and the teacher educators accept them and how they evaluate their effectiveness.

In his discussion paper, *Niels Brouwer* reflects upon the role of video and effective components that need to – or at least should – be addressed in teacher education and teacher professional development to show effective results. He takes all of the six studies presented in this Special Issue of *Orbis scholae* into account and concludes that empirical approaches, particularly by combining quantitative and qualitative approaches, push the field of video-based research forward. Beyond the methodological perspective, the six papers provide an insight into current trends in the use of video in teacher education. We believe the collection is valuable also because it is diverse in terms of the countries represented (Czech Republic, Germany, Switzerland and the USA), the target audience of the intervention (pre-service and in-service teachers), subject field (mathematics, science, English, general) and which area of influence of video they focus on (teachers' practice, professional vision and ability to notice, beliefs or acceptance of working with different videos).

As a result of the increasing number of empirical studies focused on the use of video, the growing body of empirical evidence in the field will further lead to understanding how the technology can be used to change teacher education and professional development and to foster the quality of teaching and learning.

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The editors,
Tomáš Janík, Eva Minaříková, Alexander Gröschner

Teaching Science Effectively: A Case Study on Student Verbal Engagement in Classroom Dialogue[1]

Ann-Kathrin Schindler, Alexander Gröschner, Tina Seidel

Technische Universität München, TUM School of Education

Abstract: The present case study illustrates a teacher who participated in a one-year, video-based, teacher professional development (TPD) program on classroom dialogue. This study expands the field of research on TPD by presenting the longitudinal results of Laura's teaching performance, her students' engagement in classroom dialogue, and their higher order learning perceptions. Additionally, a reflection of her participation in the TPD provides more insights into the role of TPD programs for individual teacher learning. Results revealed that Laura constantly changed her questioning and feedback behavior in terms of providing her students with more questions that foster elaboration of knowledge and feedback, which scaffolds students' learning processes. As a consequence, more students in Laura's classroom elaborated on their knowledge, which was reflected by a positive change in student higher order learning perceptions. Her reflection showed that the video tool and a mindful facilitation of the TPD program were of great value for Laura's positive learning experience.

Keywords: classroom dialogue, students' higher order learning, teacher professional development, video, case study

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1 Classroom dialogue: An effective tool to teach science?

Classroom dialogue is the predominant interaction pattern in many science classrooms (Seidel & Prenzel, 2006). However, several studies report tight communication structures in the classroom, where teachers ask narrow-focused questions and students can only provide short answers instead of rich scientific argumentations in a dialogic setting (Hugener et al., 2009; Jurik, Gröschner, & Seidel, 2013; Osborne et al., 2013). This interaction pattern places students at a risk of not being provided learning opportunities that allow the acquisition of knowledge and deep understanding (Alexander, 2005) and that awake young people's interest in a career in science, technology, engineering, and mathematics (STEM), which is in demand (OECD, 2007).

Therefore, it seems important to learn more about the elements that create a meaningful learning opportunity in classroom dialogue as well as to train teachers

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in implementing such purposeful elements in their teaching. From a research perspective, it is highly relevant to empirically examine how teachers realize their gained knowledge about productive classroom dialogue and what students' engagement in those classrooms look like.

The present case study examines the classroom of a science teacher who took part in a newly designed video-based teacher professional development program (*Dialogic Video Cycle*; DVC) (Gröschner, Seidel, Kiemer, & Pehmer, 2015). As previous results revealed that teachers in the DVC changed their performance on feedback and questioning behavior (Pehmer, Gröschner, & Seidel, 2015a), this case study provides more descriptive data regarding the central aspects of productive classroom dialogue (Chin, 2006). We examine a teacher's case who in individual analysis revealed the most significant changes regarding both questioning and feedback. We describe the case in a quantitative way by following the teacher's performance changes and the development of her students' contributions and their higher order learning perceptions throughout the duration of the DVC. This detailed case description aims to expand the field of case studies in terms of presenting a longitudinal development of performance data in connection with students' learning perceptions after her participation in the DVC program on classroom dialogue. Additionally, an interview excerpt with the teacher – whose pseudonym is "Laura" – provides support for the quantitative findings and illustrates her perception of the role of the DVC as an opportunity for professional learning. We asked the following research questions:

1. How does Laura's fostering (by means of questioning) and scaffolding (by means of feedback) of student contributions change throughout the DVC?
2. What "student talking types" can be found in Laura's classroom and how do they change throughout the DVC?
3. How do her students' perceptions of their situational learning processes and elaboration strategies change throughout the DVC?
4. What role does Laura attribute to the DVC as an opportunity for professional teacher learning?

2 Theoretical background

2.1 Productive classroom dialogue: A learning setting that fosters and scaffolds students' elaborations and higher order learning perceptions

There is a consensus in current education research that the teacher provides students with certain learning opportunities they can use, ideally with a maximum effect regarding construction of knowledge and learning outcome (Klieme & Rakoczy, 2008). In this context, there is ample evidence that classroom dialogue is a learning setting that can provide these opportunities (Furtak, 2006; Kovolainen & Kumpulainen, 2005; Mercer, 2008; Oliveira, 2010). Often classroom dialogue follows the routine of the initiation–response–follow-up (I-R-F) pattern (Cazden, 2001; Lemke, 1990), which typically starts with a teacher's question to initiate the conversation, a student responding to the teacher's question, and finally a follow-up by the teacher. Previous research found that the quality of the elements of the described conversation pattern is crucial and can be significantly influenced by the teacher (Chin, 2006; Mercer & Dawes, 2014).

Teachers' questions and feedback: Tools to frame student verbal engagement in science

There is a high demand for science teachers to create learning situations in which students can give explanations, come up with ideas, and present evidence (Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Osborne, 2010). One tool to do so is asking cognitively activating questions that challenge students to think profoundly and to use reasoning skills (Alexander, 2005; Lee & Kinzie, 2012; Wragg & Brown, 2001). Such questions prevent science from appearing to be a rigid body of knowledge (Duschl & Osborne, 2002) that can be correctly answered with one key word (Jurik et al., 2013; Mercer & Dawes, 2014). Oliveira (2010) states that questions that only allow students to give one correct key word come with students' expectations that in case of failure the teacher would provide them with the correct answer anyway. Also, students are triggered for reproducing knowledge instead of developing new ideas and concepts. She emphasizes the importance of questions to be open-ended with multiple answer possibilities, challenging to trigger students' further exploration and connecting to include students' prior knowledge (Oliveira, 2010). Thus, the quality of the question has an important function in classroom dialogue and influences how students are activated and get engaged in the conversation (Chin, 2006).

Besides teachers' questions – which foster students' verbal engagement in classroom dialogue – teacher feedback has been shown to be an important tool to scaffold students' contributions (Hattie, 2008; Hattie & Timperley, 2007). Although feedback is crucial for students' learning and motivation, studies have shown that it is rarely given but when present is often of low information content (Kluger & DeNisi, 1996; Voerman et al., 2012). In the context of "productive" classroom dialogue, it is therefore relevant whether feedback is provided and what level of feedback is included. Feedback has been shown to positively influence students' learning when it helps to restructure students' understanding by giving students hints, reinforcement, and strategies that guide students in a direction worthwhile pursuing (Hattie & Timperley, 2007). In their review, Hattie and Timperley (2007) distinguish between four different levels of feedback; these have been shown to be of different effectiveness regarding students' learning and achievement. In the present study, we focus on three of these (feedback about the task, the processing of the task, self-regulation) and not on feedback about the self.

Feedback about the task gives information on how well a student accomplished a task by differentiating wrong and right answers. It is claimed that this type of "corrective" feedback is most common because most teacher questions aim for students to give “right” or “wrong” answers. Problematic about this pattern is that students try to “pick the right answer” and equip themselves with the right strategy to achieve that aim. In comparison, *feedback about the processing of the task* concentrates on learning processes that need to be passed through to resolve a task. This type of feedback directs students in rethinking and reusing certain strategies or asking for concrete help. It can be seen as more “cueing” instead of “corrective” feedback and is more likely to enhance students’ deep understanding of tasks. This type of feedback is seen as one important productive component of classroom dialogue. Harks and colleagues (2014) back this finding and found in the context of process-oriented feedback compared to feedback by a grade (which can be interpreted as “corrective” feedback) that process-oriented feedback was perceived to be more useful with an indirect effect on students’ achievement. Another type of feedback is *feedback on self-regulation,* which promotes students’ monitoring and regulation of the learning processes. It has shown to influence, for example, students’ perceived autonomy and self-efficacy. In this context, van den Bergh and colleagues (2014) investigated whether primary school teachers’ attitude toward feedback as well as their feedback behavior would change after a video-based intervention on feedback. Results showed that teachers provided more confirmative and metacognitive feedback to reinforce their students’ learning. Additionally, teachers’ reported finding less difficulty in giving feedback to activate their students’ thinking. These findings provide another relevant hint that video-based working on a specific criterion of productive classroom discourse can change teachers’ performance and attitudes.

The listed components of productive classroom dialogue that are relevant for students’ learning and therefore should be considered for a fruitful conversational setting, independent of the content that is taught, are also highlighted by Walshaw and Anthony (2008). They integrate the aspect of student activation (e.g., through productive questioning) in their Activity 1 and the aspect of scaffolding students’ ideas (e.g., through productive feedback) in Activity 2. In the present study, those two activities served as the basis for the conceptualization of the DVC (see Section 2.2) as both activities embed central components that are highly relevant for productive student engagement (e.g., through students’ elaborations). In the present case study, we aim to provide insights to how Laura implemented her gained knowledge regarding activities 1 and 2 from the DVC into her individual teaching context.

Students’ elaborations: An indicator for students’ higher order learning in science

As stated previously, students’ elaborations are a relevant indicator of productive science teaching (Duschl & Osborne, 2010) in general. In this context, the question is: When is a student response “productive” for gaining new knowledge and improving student learning? Educational researchers agree that knowledge is co-constructed by a community of learners (Mercer & Littleton, 2007; Osborne et al., 2013; Wells & Arauz, 2006), meaning that students are to be engaged in a dialogic learning situation where they can explore and justify ideas. Thus, it is relevant that students are involved in the dialogic learning setting, and furthermore, that they are facilitated with opportunities to elaborate their reasoning (Osborne et al., 2013) rather than just reproducing knowledge – an aspect that is especially requested in the current constructivist understanding of teaching and learning. It is argued that engaging in such argumentative and interactive discourse settings allows students to construct their own scientific knowledge by challenging their own thinking, which in the long run leads to a significant rise in students' conceptual understanding (Chi, 2009; Mercer, Wegerif, & Dawes, 1999; Resnick, Michaels, & O'Connor, 2010; Webb et al., 2014). Additionally, student reasoning highlights that students' understanding of science might diverge from the teacher's expert domain knowledge, wherefore it seems reasonable that teachers facilitate students' ideas rather than just transferring knowledge to their students (Waldrip, Prain, & Sellings, 2013).

Recent approaches in teacher professional development (TPD) aim to improve students' verbal engagement in classroom dialogue. In *Accountable Talk*, for example, teachers learn about concrete *talk moves* that actively engage and connect students in conversation (Michaels & O'Connor, 2012). In the *Cam Talk* program, Higham and colleagues (2014) worked with teachers to open up their classroom dialogue so students could co-construct knowledge. In both TPD programs, case studies were conducted that provided valuable qualitative excerpts of student contributions to classroom dialogue in individual teachers' classrooms (Michaels, O'Connor, & Resnick, 2008; Van de Pol & Elbers, 2013). With the present case, we expand the field of case studies by exploring the development of "student talking types" in Laura's classroom throughout her participation in the DVC. Previous research has focused on the teacher being the main talker in classroom dialogue (Howe & Abedin, 2013), but studies rarely investigate how many students are involved in classroom dialogue and if involved, how many are elaborating on their knowledge. The present case study addresses this research gap.

How classroom dialogue affects students' higher order learning: Students' perceptions of situational learning processes and cognitive elaboration strategies

Research on TPD has found that effective interventions should lead to changes in teaching (Desimone, 2009) that also address student learning (Fishman, Marx, Best, & Tal, 2003). In this context, we concentrate on performance changes of the teacher and students as well as on students' higher order learning perceptions. Higher order learning can be characterized by *situational learning processes* that focus on the question of how students perceive their learning in a current lesson and *cognitive elaboration strategies* that determine students' use of certain strategies to support their learning in a more habitual and constant way (Vermunt, 1996; Vermunt & Verloop, 2000).

Situational Learning Processes

A positive perception of situational learning processes is an important prior condition for student learning (Donovan & Bransford, 2005). In this context, the question is whether a student is able to follow and process the lesson (processing), activate and integrate knowledge (elaborating), and structure and organize the gained knowledge (organizing). The procedures of processing, elaborating, and organizing are basically characterized as the essential *situational* elements of higher order learning (Collins, Brown, & Newman, 1989; de Corte et al., 2003; Donovan & Bransford, 2005).

Cognitive Elaboration Strategies

Beyond situational learning processes, cognitive elaboration strategies are relevant for higher order learning (Weinstein & Mayer, 1986). Cognitive learning strategies, of which elaboration strategies are a part, are assumed to be more enduring (Vermunt, 1996) and are intentionally used by learners (Zimmerman & Martinez-Pons, 1990). In the context of productive classroom dialogue in which students are verbally challenged to offer explanations and evidence (Duschl & Osborne, 2002), *cognitive elaboration strategies* are regarded as students' intentional use of strategies to connect existing knowledge to previous knowledge and using knowledge in a new context (Weinstein & Mayer, 1986).

Both facets of higher order learning are particularly relevant for deeper student understanding of learning content (Donovan & Bransford, 2005). In a previous study on the DVC, results of a pre–post comparison revealed that the whole sample of teachers participating in the DVC improved the productivity of classroom dialogue (compared to a control group), which was positively expressed by students' higher order learning (Pehmer, Gröschner, & Seidel, 2015b). In the present study, we provide more fine-grained analysis of Laura's classroom dialogue (questions, feedback, and student contributions on a speaker-turn basis) during four measuring points (instead of only pre–post analysis) and connect the findings to students' higher order learning perceptions. Based on the feasibility check of the previous study, which was conducted with a high inference rating (Pehmer et al., 2015b), it can be assumed that teachers' questions that foster students' elaboration of knowledge might positively influence their process of *elaborating* as well as their cognitive elaboration strategies on an enduring level. Due to its cuing character, which encourages students to think deeper and structure their learning (Hattie & Timperley, 2007), it can be expected that feedback on students' learning processes and self-regulation positively addresses the crucial situational learning procedures of *processing* and *organizing*. The case study, therefore, connects individual teacher performance with students' perceptions in the same classroom – a connection that is rare in case analysis and might provide informing insights for teacher educators (Grossman, 2005).

2.2 Designing an effective teacher professional development program on productive classroom dialogue in science

Components of effective teacher professional development

The demand to improve young peoples' willingness to choose careers in STEM comes with the need to enhance classroom dialogue to give students opportunities to develop a deeper understanding of STEM material and have a positive learning experience. Therefore, we aimed to develop an effective TPD program that would have an impact on classroom dialogue and as a consequence on students' higher order learning. In the conceptualization of the program, we considered evidence from previous research on effective TPD programs by implementing Desimone's (2009) components. Teachers in the program should have the opportunity to actively improve their practical knowledge and experience opportunities to apply concrete classroom dialogue activities to their daily teaching practice. We explicitly addressed effective components, such as reflecting upon their own practices related to classroom dialogue in a close community of learners (Gröschner et al., 2015). Research has shown that changes in teacher learning are more likely if teachers recognize improvement in their students' learning resulting from their newly implemented practices (Opfer, Pedder, & Lavicza, 2011).

Video is a promising tool for stimulating teacher reflection and change because purposeful excerpts can show a rich pool of (new) teaching techniques and help teachers understand their students' thinking by watching their colleagues' videos (Sherin & Han, 2004). In this context, a trustful community of learners forms an important basis for an appreciative but critical exchange about the presented video material (Gröschner et al., 2015; van Es, 2012). Video provides a connection to teachers' daily routines and opportunities for active and collaborative learning, both important aspects of a successful TPD program (Opfer et al., 2011). Video allows teachers to watch themselves from a third-person perspective without being in an active situation in a complex classroom setting. In addition, it provides a promising source of teaching examples (Tripp & Rich, 2012) and has been proven to be effective (e.g., Borko, Jacobs, Eiteljorg, & Pittman, 2008; Santagata, 2009; Sherin & van Es, 2009) for a TPD program.

With the fourth research question, this study aims to provide some insight into Laura's learning experience in the DVC by presenting an excerpt of a final video interview in which she was asked to reflect on the participation in the DVC. With this third source of data material, we intend to complete a more comprehensive picture of how TPD affects an individual teacher and learn more about how TPD is perceived individually (Buczynski & Hansen, 2010).

The Dialogic Video Cycle

Laura, the selected teacher case, participated in a TPD program with two iterations of the DVC, each cycle including three workshops and one lesson that was videotaped. The central topic of the year-long intervention was "productive classroom dialogue." As mentioned, Walshaw and Anthony's (2008) activities 1 and 2 served as the basis for each cycle. In Workshop 1, teachers received input on productive classroom dialogue from a facilitator and learned about the importance of activating students to engage in learning processes. Elements they learned, for example, were how to provide room for students' elaborations, make learning goals transparent, ask cognitive activating questions, and connect new information to students' previous knowledge. These elements were expected to activate and scaffold students' higher order learning. After the theoretical input, teachers were asked to adapt concrete techniques for student activation and scaffolding for a lesson plan each of them had provided. Next, teachers were videotaped by the research team while teaching the lesson they had revised in the first workshop. The facilitator chose video excerpts based on the criteria for productive classroom dialogue and therefore the elements teachers had worked on during the Workshop 1 in the DVC. These clips were used as a basis for the teacher reflections in workshops 2 and 3 (Gröschner, Seidel, Pehmer, & Kiemer, 2014).

Workshop 2 of each cycle concentrated on *student activation and clarifying discourse participation rights*, while Workshop 3 focused on *scaffolding student ideas and feedback*. In both workshops, teachers participating watched selected clips, posed questions about productive classroom dialogue, and jointly reflected on their experiences. In Workshop 2, teachers reflected on teaching routines that motivate students to engage in the learning process, while Workshop 3 focused instead on ways to scaffold students' learning. Here, teachers reflected, for example, on the importance of student elaborations to their statements and cognitively demanding questions as well as on making learning goals clear. Guiding questions were posed by the facilitator to support the teachers' reflections (in the case of Laura, e.g., "Which strategies of the teacher to promote student activation are discernible in the video clip?").

The second iteration of the DVC followed the same course of action, differing slightly with regard to Workshop 1 having more opportunities for transfer during Cycle 2, as teachers were more familiar with the concept of the DVC and the applicability of its elements in their classroom. The facilitator had to give more guidance for video-based reflection in Workshop 2 during the first cycle as teachers were just being introduced to working with video. Less planning elements for future lessons in Workshop 3 took place during the second cycle as this was the final workshop of the whole TPD program (for detailed implementation findings regarding DVC 1 and DVC 2, see Gröschner et al., 2015).

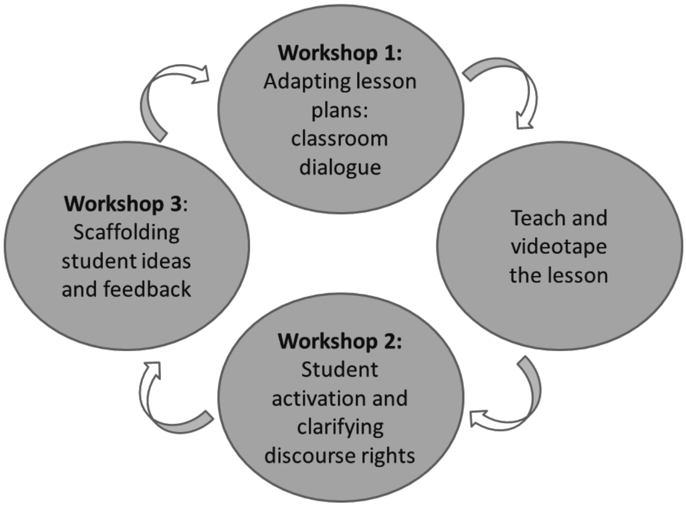

Figure 1 Dialogic Video Cycle

3 Methodology

3.1 Longitudinal mixed-method design

The DVC took place in the school year 2011/12. Its impact on teachers' classroom practice and therefore Laura's case was examined by analyzing both quantitative and qualitative data sources (see Figure 2).

Research question 1:
All participating teachers' lessons were videotaped at the beginning (pre) and end (post) of the school year along with the lessons they prepared in the course of the two DVC iterations (DVC 1 and DVC 2). Laura's case was extracted from the cohort of six teachers (for detailed case extraction and context description see Section 3.2).

All video codings related to teacher classroom practices were determined by five independent raters using the software Videograph (Rimmele, 2002). The raters were trained using video material that came from the same study but was excluded from the final data analysis. To examine changes in teachers' classroom practice, the video material was first subdivided into speaker turns (i.e., teacher, student, and no speaker) based on the event-sampling method (Bakeman, 1997).

To answer research question 1, teachers' talking turns were first coded in terms of whether the teacher was providing feedback or asking a question, independent of the instance's level. Subsequently, each teacher question was coded in relation to its level of fostering, and each teacher feedback was coded based on its level of scaffolding. The used low-inference coding systems were developed by applying

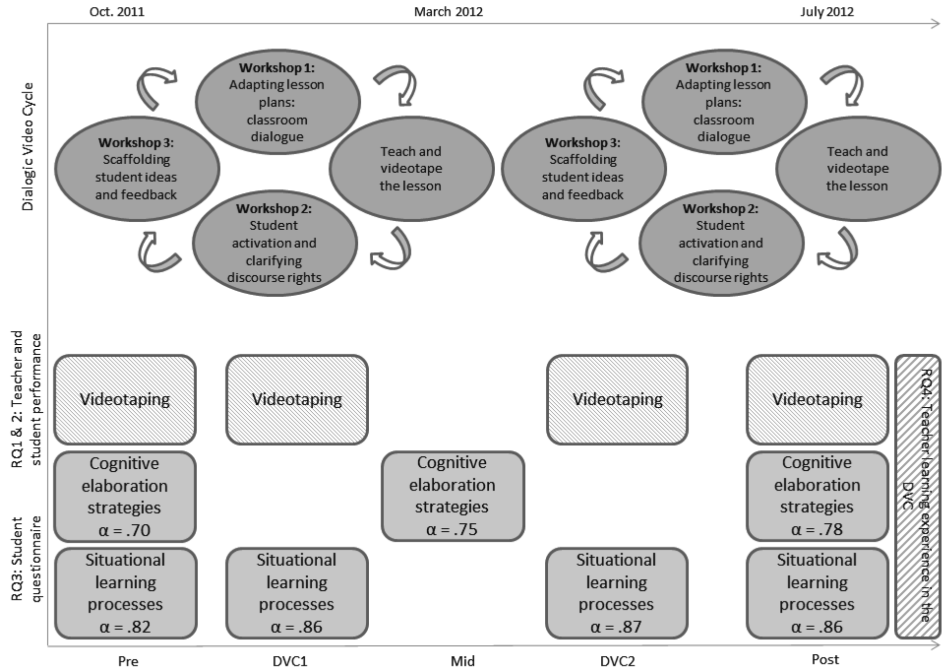

Figure 2 Design

disjunct categories (see Table 1) based on previous video studies (Seidel et al., 2003) and the literature review, which allowed for the analysis of elements of productive classroom discourse as they related to teachers' questioning and feedback (Pehmer, Kiemer, & Gröschner, 2014). The described procedure of coding pre-set talking turns according to the levels of the questions, answers, and feedback allowed for the quantification of a qualitative video analysis (Schümer, 1999). Because the study focused particularly on classroom dialogue, only talking units in whole-group classroom dialogue were considered in our analysis. Both kappa and direct consensus calculations reached satisfactory levels and are presented in Table 1.

Research question 2:
Besides teacher talking turns, each instance of student talking was coded regarding the level of students' answers (see Table 1). Additionally, each student talking turn was coded with a given number on the seating plan; this enabled a summation of the duration of each individual student for each measurement point. In a final step, each student was then categorized according to his or her "talking type," and the class composition of "talking types" was calculated for each measurement point as follows:

- *Non talking:* 0 seconds of talking
- *Only reproducing:* Aggregated duration only included reproduction of knowledge

- *Mainly reproducing:* Aggregated duration mainly included reproduction of knowledge
- *Mainly elaborating:* Aggregated duration mainly included elaboration of knowledge
- *Only elaborating:* Aggregated duration only included elaboration of knowledge

Research question 3:
For the third research question, students were questioned regarding their situational learning perceptions via a questionnaire directly after each videotaped lesson. Cognitive elaboration strategies were also measured by a questionnaire after the videotaped pre- and post-lesson as well as in the middle of the school year (mid). Due to the small sample size (28 students) nonparametric Friedman tests were applied to examine significant changes.

The following scales were applied; reliability is based on the whole student sample of a previous study (Pehmer et al., 2015b):

Situational learning processes
Students were asked about their situational learning processes during instruction directly after a lesson with their teacher. The instrument included 14 items and had a four-point Likert scale format (Seidel, Prenzel, & Kobarg, 2005). The scale comprised items reflecting basic processing ("I was able to follow the lesson the whole time"), elaborating ("I had a lot of ideas concerning the topic"), and organizing ("I was aware what was more or less important"), and had good reliability at all measurement points (α = .82–.87).

Cognitive elaboration strategies
To examine more stable and enduring aspects of higher order learning, students were asked what kind of cognitive elaboration strategies they applied during instructions. The cognitive elaboration strategy scale included five items (e.g., "I try to understand new things better by connecting them to things I already know") that were rated on a four-point Likert scale (Ramm et al., 2006), the reliability of which was satisfactory (α = .70–.78).

Research question 4:
In addition to Laura's practice changes and her students' development of higher order learning perceptions, how Laura had experienced the DVC as a professional learning opportunity was of interest. Laura conducted a short video interview on her learning experience at the end of the study; the interview clip was transcribed and qualitatively interpreted.

Table 1 Overview of video-codings and inter-rater reliability

Element of TPD program	Unit of analysis*	Categories	Example	Cohen's Kappa**	Direct consensus [%]
Preliminary work					
Speaker turn	–	– teacher – student – no one/other			98.1***
Classroom setting	T & S	– classroom dialogue**** – group/partner/single student work			85.7***
Activity 1					
I: Productive initiation: Cognitive level of question	T (frequency)	– No question		.79	89.7
		– Fostering of reproduction of knowledge	"How is this box called?"		
		– Fostering of elaboration of knowledge	"How can you manage to increase the picture on the screen?" "What is the explanation for your finding?"		
R: Productive response: Cognitive level of answer	S (duration)	– Reproduction of knowledge	"Power source"	.68	79.9
		– Elaboration of knowledge	"I think, that when I add cold water to warm water, the warmer body delivers warmth to the colder body"		

Element of TPD program	Unit of analysis*	Categories	Example	Cohen's Kappa**	Direct consensus [%]
Activity 2					
F: Productive response: Level of feedback	T (frequency)	– No feedback		.68	82.2
		– Feedback on task	"Yes", "No", "Right", "Wrong"		
		– Feedback on learning processes	"Think again, what do the results of the experiment tell us."		
		– Feedback on self-regulation	"I know that in the test you will be able to manage the task."		

* T = Teacher statement; S = Student statement.
** 784 units of analysis.
*** Only direct consensus can be reported because each rater set up own speaker turns to validate whether all raters would agree on the same amount of talking units in a video; for Kappa calculations video material with pre-set speaker turns by one person is needed.
**** Only elements of setting "classroom dialogue" are included in the analysis.

3.2 Case extraction and context description

Based on the described codings regarding teacher talking turns, Laura's case was extracted from a cohort of six teachers taking part in the DVC due to her showing a positive pre–post change regarding the level of questions and feedback in her classroom (Pehmer et al., 2015a).

Laura is 33-years old, has two years of in-service teaching experience, reportedly has experience with video-based reflection, and teaches physics (in the German context, science teachers are explicitly qualified for physics, chemistry, or biology as distinct subjects) and math in a lower secondary school (*Realschule*) within the tracked German system. For the study she participated with her ninth grade physics class of 28 students who were 15.25 years old (*SD* = .93) and 75% male. In the year before her participation in the study, she attended four hours of TPD.

Teachers participating in the DVC could freely choose the curriculum-based lesson content they wanted to teach as the DVC was not addressing a certain science topic but the activities of student activation and scaffolding of student ideas as components of productive classroom dialogue. Table 2 gives an overview of Laura's lessons for the four measurement points.

Table 2 Lesson context

MP	Topic	Lesson goals
Pre	**Volume changes** – Bullet and containers as examples: Influence of temperature on 3-dimensional enlargement	– Students develop formula for volume changes
DVC1	**Mixing temperature** – Student-centered experiment: Mixing coffee and milk and measuring temperature	– Students develop formula for mixing temperature – Students explain differences between results from experiment and calculations – Students know the energy flow from the warmer to the colder body
DVC2	**Electric current** – Example from everyday life: Policeman counting traffic flow as an example to visualize current flow	– Students are able to define electric current – Students notice physical variables that influence electric current
Post	**Electric tension** – Comparison of electric flow and water flow	– Students are able to explain the difference between electric current and electric tension – Students know how to measure electric tension

4 Results

4.1 Development of Laura's fostering and scaffolding of student contributions

In terms of teacher behavior, Laura showed a constant increase regarding both her fostering and scaffolding behavior. Regarding research question 1 (see Figure 3), results revealed that Laura entered the study with 34% of her questions fostering students' elaboration of knowledge. Throughout her participation, she constantly improved her questioning behavior (DVC 1 41%; DVC 2 48%) up to 65% of her questions fostering students' elaborations.

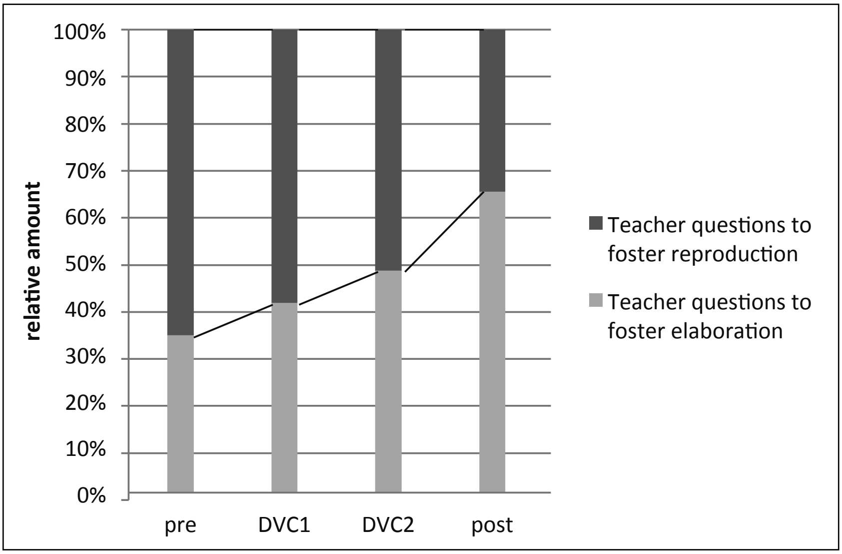

Figure 3 Fostering of student contributions in Laura's classroom

Regarding scaffolding of students' contributions, she initially gave 5% feedback on students' learning processes. During the school year, she changed her scaffolding by providing her students with 13% (DVC 1), 12% (DVC 2), and 16% (post) feedback on their learning processes. The level of feedback on self-regulation slightly changed during the DVC, starting with a relative frequency of 17% up to 21% (DVC 1), 22% (DVC 2), and 22% post.

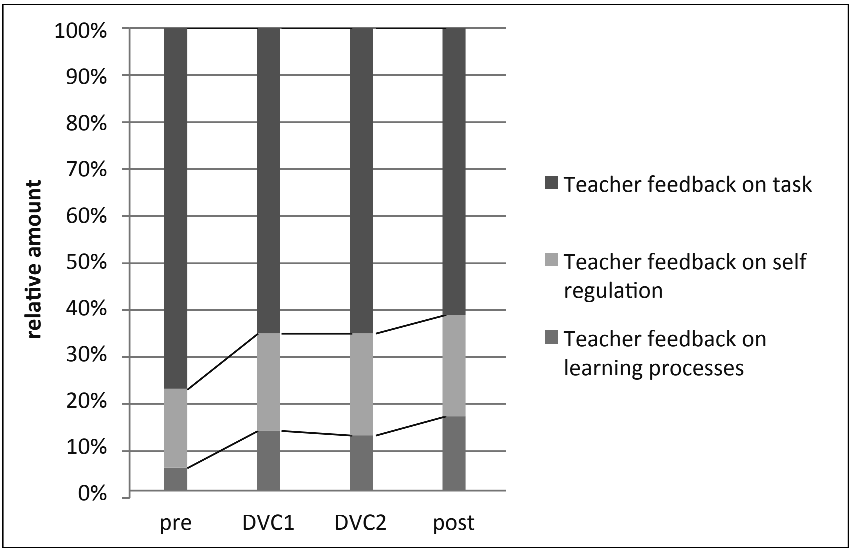

Figure 4 Scaffolding of student contributions in Laura's classroom

4.2 Development of student "talking types" in Laura's classroom

Whereas for research question 1, results revealed a constant positive development; during the first half of the academic year, composition of student talking type was comparable and no development from pre to DVC 1 could be shown. As illustrated in Figure 5, results of research question 2 showed that when entering the study, 15% of Laura's students were not talking during the videotaped lesson; 41% were only and 15% mainly reproducing knowledge; and 19% were mainly and 11% only elaborating on their knowledge. During DVC 1, the talking type composition of Laura's classroom was similar with again more than half of students either not talking (29%) or only reproducing knowledge (29%); 14% of students were mainly reproducing knowledge and 14% mainly and 14% only elaborating knowledge.

In comparison, the second iteration of the DVC revealed a changed talking type composition. During DVC 2, non-talkers (8%) and only reproducing knowledge (27%) declined to one-third of students, which is in parallel with half of Laura's students mainly (46%) or only elaborating knowledge (4%). Post measurement showed – in comparison to the beginning of the study – improvement in terms of 27% of students mainly and 12% only elaborating knowledge. At the end of the study, 23% of students remained non-talking and 23% only and 15% mainly reproducing knowledge.

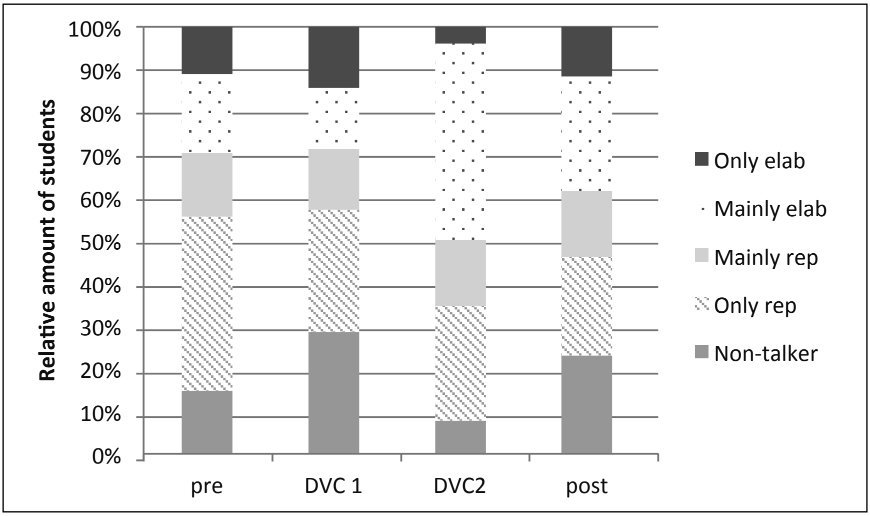

Figure 5 Development of student talking type composition in Laura's classroom dialogue

4.3 Development of Laura's students' higher order learning perceptions

Results of the third research question partly mirrored composition of student talking types. The examination of students' higher order learning perceptions showed that students reported their situational learning processes more positively during DVC 1 (M = 2.03, SD = .45) and highest during DVC 2 (M = 2.11, SD = .47). These were the les-

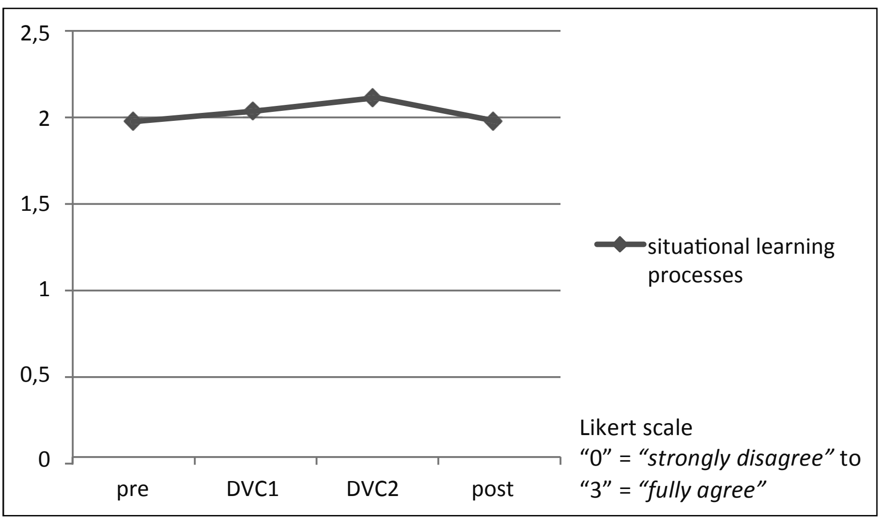

Figure 6 Development of students' perceptions of situational learning processes

sons teachers had planned collectively and for which DVC 2 showed more productive talking type compositions with more students elaborating on their knowledge. At post-test, students perceived their situational learning processes on the same level as at the beginning of the study (M = 1.97, SD = .59). The Friedman test did not reveal a significant effect (x^2 (3, 17) = 3.88, *n.s.*) and neither did post-hoc tests.

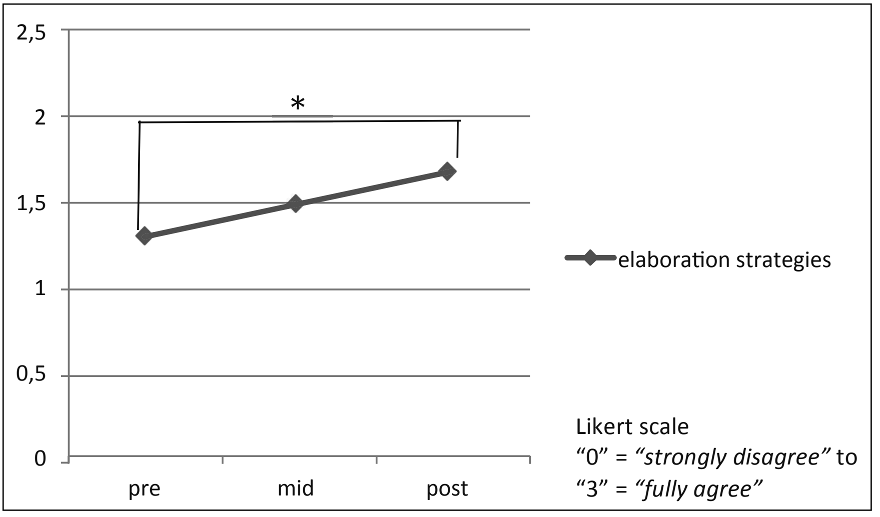

Figure 7 Development of students' perceptions of cognitive elaboration strategies

Regarding students' cognitive elaboration strategies, students showed a constant positive change throughout the intervention (M_{Pre} = 1.29, SD = .58; M_{Mid} = 1.48, SD = .54; M_{Post} = 1.67, SD = .49). An overall effect (x^2 (2, 23) = 14.28, p = .00) could be shown for the stable facet of higher order learning, which, based on the post-hoc testing, was due to the increase from pre to post. The more enduring cognitive elaboration strategies seemed to positively stabilize throughout the DVC.

4.4 Laura's learning experience in the DVC

In a final short video interview in which Laura was asked to talk about her learning experience in the DVC, she responded as follows:

> I would definitely participate again. I think it was great because by watching oneself and getting feedback one learned a lot, especially student activation and giving praise. And I remember this in several situations, especially with the younger ones [her younger classes]. […] The atmosphere in the group was good. There was not a single moment where I thought I'd rather say nothing. All of the colleagues were really fair and constructively critical, if even. Often I judged my teaching much worse and thought "Oh my God" [puts hands on her head] but they [the other participants] found aspects I was doing well. That was phenomenal […]. Also the amount of meetings was good. And it was facilitated in a great way, really kind of a family atmosphere.

In her statement, Laura appreciated working with the video tool because it gave her the chance to watch herself; also video stimulated her to think about her teaching where she experienced herself to be the most critical teacher. Video also allowed her to open her classroom to the rest of the group who highlighted her teaching strengths. In the given excerpt, she also mentioned the aspects of student activation (e.g., questioning) and praise (e.g., as a form of feedback on self-regulation) and that she learned a lot about those components. She also provided insight that the aspects she learned were not only relevant for the class she was participating with in the DVC but also for other classes she teaches as she could transfer her newly gained knowledge. At the end of the excerpt, she referred to the duration of the TPD and that this was appropriate for her. She also emphasized how important the mindful facilitation (Gröschner et al., 2014) was for her learning experience in the DVC.

5 Discussion

The present study illustrated the case of a science teacher who participated in a video-based TPD program on classroom dialogue. Our aim was to illustrate a teacher who successfully changed her questioning and feedback behavior in a previous pre–post comparison (Pehmer et al., 2015a). Therefore, we examined in a first research question how Laura's questioning and feedback behavior would develop throughout the participation in the DVC (all four measurement points) (research question 1). In research question 2, the change in student talking types in terms of elaboration of knowledge was explored. Research question 3 examined how Laura's students would perceive their situational learning processes and cognitive elaboration strategies differently throughout their teacher's participation in the DVC. To summarize the case study, we examined in research question 4, how Laura experienced her learning in the DVC.

The quantitative exploration of Laura's performance development aimed to expand the field of mainly qualitative case study research. Also the connection of individual teacher and student performance with student learning perceptions is rare in this context. For a rather "holistic" picture, Laura's learning experiences in the DVC were examined, and thus this study helps to better understand how TPD affects individual classrooms (teacher and students) to generate knowledge, not least for teacher educators and prospective research (Grossman, 2005).

Results regarding Laura's performance development revealed constant changes in her questioning and feedback behavior. Throughout the participation over the period of an academic year, Laura constantly worked on the productivity of classroom dialogue with regard to components she, as a teacher, could influence decisively. She entered the study with a third of her questions fostering student elaboration and almost no feedback on students' learning processes. Her questioning changed to a level of two-thirds of her questions fostering her students to elaborate on their knowledge at the end of the academic year. Analysis of the composition of student talking types in her classroom showed that changes on the students' side needed longer establishment as no changes occurred during the first iteration of the DVC but improvement was seen in DVC 2 and a slight decrease for the post-measurement point; essentially a higher level of student elaborations occurred compared to the beginning of the study. During the lesson in DVC 2 that teachers had collectively planned, half of the students elaborated on their knowledge in classroom dialogue. The fact that many students were elaborating on their knowledge in classroom dialogue during DVC 2 is also reflected by students' perceived situational learning processes, which were most positive during DVC 2. Regarding cognitive elaboration strategies, students reported an increase throughout the school year and perceived them as reasonably higher at the end of the study. The qualitative analysis of her interview showed that video was a fruitful learning tool for Laura because it encouraged critical self-reflection but also opened her classroom to other colleagues who highlighted her teaching strengths. She particularly highlighted the duration and facilitation of the DVC, two components that were carefully considered when designing the DVC (Gröschner et al., 2015).

The attempt of a systematic, multiperspective case description provided further important knowledge regarding the impact of TPD on individual teaching contexts. It is known that TPD is practiced in very different contexts (Vescio et al., 2008) due to teachers implementing their gained knowledge in their individual teaching setting (Pennings et al., 2014). Buczynski and Hansen (2010) report that it was individually challenging for teachers to implement aspects they had learned in the TPD program. With the present case, we illustrated a teacher who successfully implemented two central components she had learned – questions that foster student elaborations and feedback that scaffolds students' contributions. At the beginning of the study, Laura's questioning behavior supports previous results regarding German classroom dialogue; these are often tight interaction patterns with questions that trigger students to reproduce knowledge and to serve as key word givers rather than equal conversational partners (Hugener et al., 2009; Jurik et al., 2013; Lipowsky et al., 2009). Working with teachers on classroom dialogue that underlies routine and establishment (Morton, 2012) is challenging because new teaching techniques are required to overcome given patterns. Throughout the participation in the DVC, Laura managed to break this tight interaction routine by opening her questioning in terms of fostering her students to elaborate on their knowledge. Her changing routines constantly improved, whereas student talking types followed a slightly different route. Throughout the TPD, students in Laura's classroom tended to elaborate more on their knowledge, which was at its peak during DVC 2. The peak can be explained by Laura's chance to reflect on her teaching in the first DV cycle and apply this to her teaching during the second iteration of the DVC. In addition, teachers were already familiar with the concept of collective lesson planning, which can be interpreted as another supportive factor (Desimone, 2009) for a more productive classroom dialogue in terms of students' elaborations during DVC 2. For the last videotaped lesson, there was no collective planning, which might have caused less productivity in students' contributions, although still more productivity in Laura's fostering and scaffolding. Teacher questioning and feedback are facets of classroom discourse that are directly influenced by the teacher and therefore, with regard to our findings, might underlie a more constant development manner. As a consequence Laura's students contributed to classroom dialogue in a more elaborative way throughout the study but not in the exact same development curve. The importance of teachers' questions as triggers for students' answers (Alexander, 2005; Lee & Kinzie, 2012; Wragg & Brown, 2001) and feedback as an important scaffolding tool (Hattie & Timperley, 2007) are emphasized in the research literature. Additionally, the importance of establishing a certain communication culture in terms of participation rights and responsibilities is highlighted (Walshaw & Anthony, 2008). In this context, students' talking type composition needed the first half of the academic year as establishment time and showed a slight variation during the second half.

This development is also mirrored by students' reported perceptions. There is ample evidence that elaborating and arguing knowledge is essential for the development of students' understanding (e.g., Webb et al., 2014) and positive learning perceptions (Pehmer et al., 2015b). The examination of Laura's students' learning perceptions showed that at DVC 2, where half of her students' were elaborating on their knowledge, students reported their situational learning perceptions the highest. At the end of the school year, slightly fewer students in Laura's classroom elaborated, which is also expressed in students' situational learning perceptions. They reported their situational learning perceptions to be on the same level as when entering the study. The DVC, therefore, helped the teacher to prevent students from showing decreases of positive learning perceptions in science, which are of concern in educational research (Häussler & Hoffmann, 2000; Sjøberg, 2002). Students' cognitive elaboration strategies developed positively throughout the school year. Laura's case confirms previous findings that students' perceptions of situational learning processes are, as expected from their designation, dependent on momentary learning environments (de Corte et al., 2003; Donovan & Bransford, 2005). Cognitive elaboration strategies are more stable (Vermunt, 1996), and several positive learning experiences are needed for students to become manifest in their positive perceptions of learning strategies. The increase in the post-test can be explained by positive situational learning perceptions during DVC 2 that positively influenced students' cognitive elaboration strategies in the long run.

Laura's case furthermore showed that efforts in TPD can be successful, a fact that is not given per se, particularly when teacher performance and student learning outcomes are addressed. Vescio and colleagues (2008) stated in their review of studies on the effectiveness of TPD that well-developed programs have a positive impact on teaching practice and student outcomes. In this context, the DVC was carefully designed with regard to providing teachers with options for active learning and reflection in a community of learners who worked together for an entire school year (Gröschner et al., 2015). From TPD research in Germany, it is known that teachers often visit single workshops that are not necessarily connected to daily teaching routines (Richter et al., 2011). Laura especially appreciated working with video in a trustworthy community of learners with a professional facilitator (Gröschner et al., 2014). This learning environment can only be created if TPD takes place over a certain period of time (van Es et al., 2014). With regard to the duration of the TPD program (in total 22 hrs.), Laura emphasized that the number of meetings was appropriate. These insights into her learning experience help to further press efforts of TPD conceptualization in the direction of designing programs that take place over a longer period of time in a constant learning community. In her case, the DVC, as an effective TPD program approach (Gröschner et al., 2015), could lead to positive performance changes, changes to student higher order learning perceptions, and a positive learning experience for herself.

Besides positive changes, her case analysis also delivered results that helped to further improve the DVC and its elements. In future TPD efforts, teachers need to obtain better awareness about the rather proximal teacher talking elements, like questioning and feedback which teachers can directly influence by changing their own behavior, which serve as important triggers for student engagement in classroom dialogue. Additionally, teachers need to develop an awareness of establishing a productive participation culture, which means breaking routines and introducing students to discourse structures they might not be familiar with from other lesson contexts. For example, one problem regarding her communication culture that Laura could not solve was the non-talking students in classroom dialogue. The topic of non-talkers and also the question of how a large number of students can be activated in classroom dialogue need to be addressed in future DV cycles. Future research could, therefore, investigate the frequency of student activation and balance of different students engaging in classroom dialogue as the current study does not reveal results on individual engagement and learning perception changes. In a future project, we aim to follow Howe and Abedin's (2013) assertion for more knowledge on the value of certain dialogic settings, and the topic of non-talkers will be a focus in the DVC, which will address the choice of dialogic settings as one important tool to engage all students in the conversation. Also the question of individual student engagement in different dialogic setting will be examined as the current study is limited to engagement in whole group discussions. The present results cannot provide a conclusion about Laura's timing of different levels of questions and feedback, which is highlighted as an acknowledgeable aspect by Hattie and Timperley (2008). In future research, this will be addressed in the DVC program, which will train teachers in becoming facilitators of classroom dialogue who are aware of the timing and function of different types of feedback and questions. Finally, a benefit and limitation at the same time is the fact that we chose a teacher who successfully implemented components of the TPD in her classroom. As stated at the beginning, classrooms are complex individual settings and teachers are confronted with different conditions that might allow for easier or more difficult implementation of gained knowledge from TPD (Buczynski & Hansen, 2009). The question is therefore, how a successful change in dialogic teaching could be transferred to other classrooms – with a different group of students and their individual pre-requisites. More empirical evidence is therefore needed that addresses how TPD can be successfully conceptualized to lead to performance changes as well as positive student learning outcomes, including in other domains of knowledge and beliefs.

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Ann-Kathrin Schindler
TUM School of Education, Technische Universität München,
Arcisstraße 21, 80333 Munich, Germany
ann-kathrin.schindler@tum.de

Alexander Gröschner
TUM School of Education, Technische Universität München,
Arcisstraße 21, 80333 Munich, Germany
alexander.groeschner@tum.de

Tina Seidel
TUM School of Education, Technische Universität München,
Arcisstraße 21, 80333 Munich, Germany
tina.seidel@tum.de

Practice What You Teach: A Video-Based Practicum Model of Professional Development for Elementary Science Teachers[1]

Eric Berson, Hilda Borko, Susan Million, Edit Khachatryan, Kerri Glennon
Stanford University, Graduate School of Education

Abstract: This study examines an innovative professional development program that provides teachers with an opportunity to practice pedagogical strategies in a low stakes classroom context. Elementary teachers participated in a one-week summer Institute and two-week Practicum focused on learning strategies for facilitating scientific discourse and argumentation in their classrooms. During the Practicum, teachers taught lessons in a summer program for elementary school students and engaged in daily video-based discussions to reflect on their instruction. This study identified the instructional practices that were most emphasized during the Institute and examined the extent to which teachers took up those practices during the subsequent practicum experience. A classroom vignette illustrates how one teacher engaged her students in the discourse practices, and a coaching vignette portrays her video reflection group's discussion of the episode. Findings suggest that the focal instructional practices were taken up to different degrees during the Practicum, and that opportunities for practice and reflection are potentially valuable features of professional development programs. The project illustrates the value of video as a tool for both professional development and research.

Keywords: professional development, science talk, pedagogy, science education, science instruction, classroom video

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A growing body of empirical research on the structure, content and outcomes of effective professional development (PD) provides insights about the characteristics of programs that provide high-quality, high-impact learning opportunities for teachers. As Desimone (2009) argues, "there is a research consensus on the main features of professional development that have been associated with changes in knowledge, practice, and, to a lesser extent, student achievement" (p. 183). These features include: 1) a focus on subject matter content and how students learn that content;

[1] The PRACTISE Project is a collaboration between the Lawrence Hall of Science at the University of California, Berkeley and the Graduate School of Education at Stanford University. We want to thank our collaborators at the Lawrence Hall of Science: Craig Strang and Emily Weiss, who developed the Academy professional development model and are leading the PD in this project; and Bernadette Chi, who is leading the evaluation component. We also thank Jonathan Osborne, our colleague at Stanford University who is one of the principal investigators on the project, and all of the teachers who have so generously given their time to the project and welcomed us into their classrooms. Without their ongoing contributions and support, this study would not have been possible. Researching the Efficacy of the Science & Literacy Academy Model is funded by a grant from the National Science Foundation (#1220666).

2) opportunities for teachers to engage in active learning; 3) coherence, which includes consistency with both teacher knowledge and beliefs, and school, district, and state policies; 4) sufficient duration, in terms of number of hours and span of time; and 5) collective participation. Borko, Jacobs and Koellner's (2010) review of contemporary approaches to PD identifies two additional, related features: that PD be situated in the practice of teaching, and that PD leaders model preferred instructional strategies so that participating teachers have the opportunity to experience the strategies as learners and then reflect on their effectiveness from the perspective of teacher-learners.

Randomized controlled experiments offer some evidence that PD programs designed in accord with the features of effective PD can produce significant gains in teacher knowledge and instructional practices (e.g., Bell et al., 2010; Heller et al., 2012) and student learning (e.g., Heller et al., 2012; Penuel, Gallagher, & Moorthy, 2011). For example, Heller and colleagues compared the effects of three PD programs focused on electric circuits that used three different approaches – teaching cases, analysis of student work, and metacognitive analysis – as well as a business-as-usual control condition. Each PD program significantly increased teacher and student science test scores beyond those of the control group, and the effects held one year later.

Other studies, however, show that simply including these features is not sufficient to ensure positive impacts for either teachers or students. Two randomized controlled studies by Garet and colleagues, one focused on early reading instruction (Garet et al., 2008) and the other on middle school mathematics (Garet et al., 2011), provide a case in point. Their study of PD for early reading instruction, for example, compared a PD program that included a content-focused summer institute and school-year seminar days, a second treatment that provided the summer institute plus a half-time coach in each participating school, and a business-as-usual comparison group. The PD interventions had a significant impact on teacher knowledge of early reading content and some aspects of their instruction. However, these effects were not maintained in the year following the intervention. Further, the programs had no impact on students' reading achievement.

These mixed results suggest that existing conceptual frameworks for effective PD are not sufficient to ensure that the PD will effect change. One possible reason is that the features are underspecified. Given the lack of consistent empirical findings in research on professional development in science education, Wilson (2013) suggests that more empirical research is needed to "identify the underlying mechanisms that make some teacher professional development (PD) programs more effective than others" (p. 312). She argues for better specification of target instructional practices that are the focus of the PD, more highly theorized mechanisms of teacher learning and improved outcome measures.

One characteristic that several PD programs with some evidence of effectiveness have in common is the use of classroom video as a tool for bringing the central activities of teaching into the PD setting (Koellner & Jacobs, 2015; Seago et al., 2013;

van Es & Sherin, 2010). Like other records of practice, such as examples of student work and instructional materials, video provides an opportunity for teachers to collaboratively study their practice without being physically present in the classroom (Borko et al., 2014). Clips from videotaped classroom episodes can be viewed repeatedly and from multiple perspectives, enabling teachers to closely examine classroom interactions, as well as the content addressed in the lessons, and to discuss ideas for improvement. The Practicum Academy for Improving Science Education (PRACTISE) PD model that is the focus of this article incorporates all of the features of effective PD identified in the literature. In addition, it identifies a specific set of instructional practices to foster students' argumentation from evidence and emphasizes time dedicated for teachers to enact and refine these instructional practices in a low-stakes practicum experience. Video plays a key role in both the PD experience and the research. In the PD, teachers share video of their practicum teaching and receive feedback from colleagues and PD leaders. The primary data sources for the analyses presented in this article are video-recordings of the program's summer Institute and Practicum experience.

1 The Practicum model of professional development

Changing teaching practices involves uncertainty, room for reflection in order to understand the emerging patterns of change, a community to share experiences, and opportunities to test what works or does not work in classrooms (Jennings & Mills, 2009; Martin & Hand, 2009). During the school year, external constraints such as time, state standards, testing requirements, and instructional resources can prevent teachers from having the opportunity to practice new instructional moves or reflect on practices collaboratively with peers. The structure and constraints of schools can limit teachers' implementation of new strategies regardless of changes to their knowledge or beliefs.

Practicum experiences enable teachers to focus on changing their practice without such constraints or outside pressures. Practicums – courses designed to provide supervised practical application of previously or concurrently studied theory and methods – while uncommon in PD for veteran teachers, are a hallmark of professional preparation in teaching as well as fields of study such as medicine, nursing and social work (Ryan, Toohey, & Hughes, 1996). In the professional development program that is the focus of this article, PD leaders introduce teachers to the theory and research on the role of scientific discourse in student learning, and they model a variety of instructional practices for facilitating scientific discourse in classrooms. The practicum provides opportunities for teachers to enact the practices in authentic contexts, reflect upon their experiences and receive feedback, and then modify their practice the following day. Video clips from the practicum lessons feature prominently in the reflection and feedback sessions.

2 The Practise professional development program

The Practicum Academy for Improving Science Education (PRACTISE) project was designed to study the efficacy of an innovative model for science professional development for upper elementary (grades 3–5) classroom teachers. In an evaluation of previous practicum-based Academies, evidence from teacher surveys and interviews indicated that teachers make significant shifts in their knowledge and beliefs, and that they are comfortable with implementing new practices they have learned (Chi et al., 2011). The PRACTISE research project enables us, for the first time, to collect evidence of actual changes in practices that result from the practicum-based PD, and to compare the effects of PD with and without the practicum experience.

The PRACTISE project's goal is to develop teachers' skills in engaging students in productive science discourse and argumentation. The decision to focus on scientific discourse is grounded in theory, empirical findings and policy. From a theoretical point of view, language is an instrumental tool for constructing understanding and developing concepts (Billig, 1987; Vygotsky, 1962). Empirical research has shown that opportunities for students to engage in collaborative discourse – to advance claims, support their ideas, be challenged and challenge others – lead to improvements in students' conceptual understanding and scientific reasoning (Asterhan et al., 2007; Chi, 2009; Mercer et al., 2004; Zohar & Nemet, 2002). The policy driver for focusing on scientific discourse and argumentation is the release of the *K-12 Framework for Science Education* (NRC, 2012) that identified argumentation as a key scientific practice. Taken together, these factors shape the focus of the PRACTISE project on science discourse and argumentation.

The PD model (aka "Academy") consists of three components – an *Institute*, a *Practicum*, and *Follow-up sessions*. The intensive, week-long summer Institute focused on helping teachers learn how to facilitate scientific discourse and, specifically, argumentation from evidence, through engaging students in reading science texts and conducting inquiry-based science investigations. At the Institute, the teachers were introduced to an inquiry-based curriculum about oceans with a focus on what causes ocean currents. The PD leaders oriented the teachers to the curriculum by modeling many of the lessons and investigations. They also modeled a variety of instructional practices designed to support scientific discourse and argumentation among students.

Following the Institute, approximately half of the teachers spent an additional two weeks in a teaching Practicum. During the Practicum, they taught science and literacy in teams for approximately two hours each morning in a local summer school program. They then spent the afternoon reflecting on their instruction and planning for the next day. The Practicum experience was designed to allow teachers to: practice instructional strategies that they had learned in the Institute in a highly supported, low stakes environment; analyze videos of their teaching practice; reflect on their practice and receive feedback from colleagues, science coaches, and literacy coaches; then adapt their instructional practices for the following day on the basis of that feedback.

Eight teams of teachers (comprised of 2–3 teachers each) were assigned to an instructional coach and a class of summer school students who were entering 3rd, 4th or 5th grade in the fall. The teams were expected to follow the ocean science curriculum that they had worked with the prior week at the Institute. The teachers decided how to pace the lessons and where to integrate science discussion. While most teacher teams planned jointly, they often took turns as the lead instructor for a particular lesson or day of instruction. Each teacher was also responsible for facilitating a discussion or activity with a small group of students each day.

In the afternoons, teachers from two teams combined into a single discussion group to discuss a video clip that one of the teachers had selected from the prior day's instruction, in consultation with their instructional coach. The goal of the discussions was to provide a supportive and safe setting for teachers to reflect on how their instructional practices were developing. The clip provided the springboard for discussing an aspect of the teacher's own practice that the teacher wanted to explore with his or her colleagues. The teacher framed the activity with a question for the group to consider as they watched and discussed the clip.

The third component of the Academy is a series of follow-up sessions conducted during the academic year, designed to provide guidance and support for teachers as they incorporated the new instructional practices into their ongoing classroom instruction.

To test the efficacy of the Academy model, professional development facilitators enacted two versions of the PD: the full Academy (Institute, Practicum and Follow-up days) and the Academy minus the Practicum (Institute and Follow-up days only). The multi-year research project is examining the impact of the different versions of the PD on teachers' instructional practices and student learning outcomes.

3 Research questions

The study reported in this article highlights one specific component of the overall PRACTISE project – the summer Institute and Practicum during the first year of the project. More specifically, we trace the instructional practices emphasized in the Institute through the teachers' enactment of those practices in the subsequent Practicum experience. The following research questions guided our analysis:

1. Which instructional practices were most prominently communicated to teachers during the summer Institute?
2. How and to what extent were these instructional practices taken up by teachers during the Practicum?

To address these questions we analyzed the discourse practices highlighted in the summer Institute and the discourse practices enacted by the teachers in their Practicum classrooms. In addition, we conducted an initial vignette analysis to begin to explore the relationship between the Practicum's teaching experiences and reflective coaching sessions. In the following sections, we first describe the participants and data sources for the study. We then present the analytic methods and results for the analysis of the Institute, followed by analysis and results for the Practicum. We conclude with the vignette to illustrate how video was used to support teacher reflection.

4 Participants and data sources

In this section, we describe the participants and data sources we used to investigate our research questions. The larger research program included additional data sources and research methods.

4.1 Participants

All teachers in the project were recruited from a large, urban school district in Northern California. Twenty teachers in *Group 1* participated in the Institute and Practicum, and 24 teachers in *Group 2* participated in the Institute only. During the Practicum, Group 1 teachers taught in teams. The analysis in this study focuses on two teams that convened together with their coaches in the afternoon to reflect on their instruction using video. The video reflection group included five teachers: two taught as a pair in one classroom, and three taught as a trio in a second classroom. The teachers had between 2 and 11 years of prior teaching experience and all but one were female. We selected this video reflection group to analyze because one of their coaches was one of the principal investigators for the overall project, and we reasoned that he would be coaching with high fidelity to the goals of the project. Due to resource limitations, we alternated between the two classrooms during the Practicum teaching, as represented in *Figure 1*.

4.2 Data sources

To investigate our research questions, we analyzed data from three sources. First, we videotaped the summer Institute attended by all participating teachers. The video included all of the presentations, activities and discussions facilitated by the PD leaders. The second data source was video of the classroom instruction during the teaching Practicum. We analyzed instructional video from the five teachers who were in the focal video reflection group. The third was video of the afternoon video reflection discussions that these five teachers had with their coaches. We describe how these data were analyzed in the sections below.

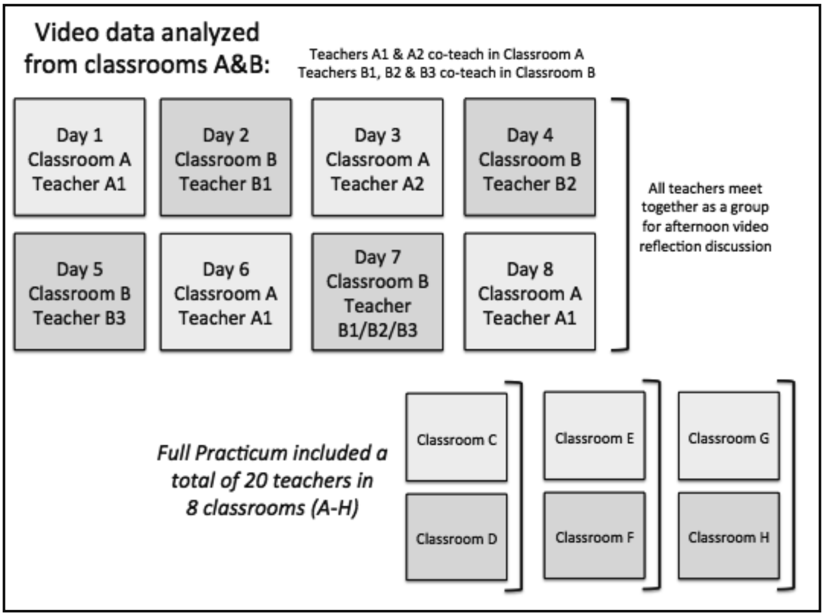

Figure 1 Practicum schematic illustrating the sample video used for analysis

5 Analysis and results

In this section, we present the analyses and results for two inquires: teacher and student discourse practices emphasized during the Institute, and practices taken up during the Practicum. We then present vignettes that illustrate the two components of the Practicum experience − a classroom vignette depicting the dialogic nature of the teacher and student practices, and a vignette depicting the nature of video reflection discussions during the afternoon coaching sessions.

5.1 Discourse practices emphasized in the Institute

The goal of the summer Institute was to teach teachers how to engage students in productive scientific discourse and, specifically, argumentation from evidence. In light of this stated goal, we sought to identify the instructional practices that were most prominently communicated to teachers during the Institute.

Analysis

Our first step in analyzing the data was to watch video of the Institute to identify and document the teacher and student discourse practices that were introduced during the Institute workshops. The PD leaders utilized a variety of presentation formats to communicate instructional practices including: 1) modeling science lessons with teachers as learners; 2) debrief sessions to reflect on the model lessons; 3) lectures or presentations; and 4) other types of teacher learning activities (e.g., jigsaw readings, creation of concept maps). In some cases, specific instructional practices were *explicitly* communicated to teachers by the PD leaders. For example, they explicitly suggested that teachers try out a particular instructional practice with their students. In other cases, the instructional practice was communicated *implicitly* by modeling the practice during the demonstration lessons. There were also instances when teachers raised particular instructional practices, often during the debrief sessions.

Our initial analysis of the Institute video records yielded a broad set of instructional practices that were mentioned or modeled at least once during the Institute. Next, we reduced the set of practices to include only those that were a) most closely relevant to supporting scientific discourse and argumentation; and b) *explicitly* communicated to teachers on one or more days of the Institute. This process yielded a set of 15 teacher practices and 5 student practices. We created a coding manual that included definitions for each of the practices in this set, which we then used in the analysis of Practicum lessons.

Results

Table 1 lists the primary teacher instructional practices. The teacher practices included practices aimed at establishing classroom norms for productive discourse such as language to use when disagreeing with other students' ideas, sentence frames, active listening, speaking loudly enough to be heard and encouraging wide participation from students in the discussion. A second set of practices involved making particular pedagogical moves to support student discourse such as pressing students for evidence, revoicing students' ideas, adding to or linking students' comments and soliciting additional student ideas. A third set of practices focused on documenting student ideas. One practice that was emphasized is the use of a T-chart which graphically organizes evidence that either supports (left column) or refutes (right column) a claim (at the top). More generally, teachers were advised to write down key student ideas such as observations or claims as a way to support discourse. The last set of teacher practices focused on the role of writing to support discourse, including asking students to write or draw their ideas before engaging in a class discussion and providing scaffolds for writing such as prompts and graphic organizers.

The only teacher practice that was part of the Institute that we decided not to include in the list or in our analysis of the Practicum was the practice of asking questions. Asking questions is central to generating classroom discussion and was explicitly addressed in the Institute. However, we excluded this practice because the primary questions that teachers were expected to use during the Practicum were provided in the curriculum materials they were given rather than generated by the teachers.

Table 1 Teacher practices communicated during the Institute

Practice	*Definition*
Norms for Discourse	
Language to Disagree	Teacher encourages student to use phrases such as "I agree" or "I disagree" when referring to each other's comments.
Sentence Frames	Teacher encourages students to use particular rhetorical frames (e.g., "I think____ because___") to support academic discourse in the classroom.
Active Listening	Teacher reinforces importance for students to show each other that they are listening.
Speaking Loudly	Teacher encourages students to speak loudly and/or clearly in order to allow other students to hear each other's ideas.
Wide Participation	Teacher elicits responses from different students. The teacher may use equity sticks or other devices to encourage students to participate.
Gestures	Teacher elicits gestures from students as a way of responding to a question or expressing their ideas.
Discourse Moves	
Press	Teacher asks students to elaborate, clarify or support their claims, often by asking for evidence or reasoning.
Revoice	Teacher revoices, paraphrases or otherwise summarizes a student's thought or idea.
Adding to/Linking/ Building	Teacher makes a connection between two or more different ideas that have been expressed in the discussion to show how they relate to each other.
Solicit More Ideas	Teacher asks for more ideas or thoughts from the students who have not yet shared.
Charting Student Ideas	
T-Chart	Teacher uses a T-chart that scaffolds the documentation of evidence for and against a particular claim or claims.
Recording Ideas (non-T chart)	Teacher documents students, ideas or thoughts in a public place (e.g., the board, chart paper)
Writing to Support Talk	
Writing Activity	Teacher asks students to write down their ideas (e.g., observations, claims, evidence) as a way to support discourse.
Scaffolds for Writing	Teacher provides scaffolds for writing, such as sentence frames or writing organizers, in an effort to support discourse.
Asking Students to Draw Ideas	Teacher asks students to draw their ideas in an effort to support discourse.

Table 2 lists the main student practices that were emphasized during the Institute. These practices reflect the different kinds of productive student contributions that are facilitated by the teacher practices. The student practices communicated during the Institute workshops included making initial claims or predictions, supporting claims with evidence, revising claims, critiquing the claims made by others and using prior knowledge and new resources. Taken together, these student practices are central to the goals of the professional development and at the core of productive classroom discourse.

Table 2 Student practices communicated during the Institute

Practice	Definition
Make Initial Claims or Predictions	Students make initial claims or predictions that reflect their ideas.
Support Claims with Evidence	Students support their claims with evidence. This rubric characterizes the degree to which the students are supporting their claims with evidence.
Revise Existing Claims	Students revise an existing claim based on evidence or discussion.
Critique Claims	Students critique claims by citing counterevidence or disagreeing with each other's statements.
Use Prior Knowledge & New Resources	Students use prior knowledge or resources (e.g., prior experiments, readings) to support their claims.

5.2 Practicum instructional practices

Having identified the set of teacher and student practices communicated during the Institute that fit our criteria, we then analyzed the extent to which teachers and students engaged in those practices during the Practicum experience.

Analysis

To analyze the extent to which teachers tried out the Institute practices during the Practicum, we created a rating schema based on the set of practices we identified in the Institute analysis (see Table 1 and 2). We watched video of morning instruction in one Practicum classroom during each of the 8 days of the Practicum. Since there was a team of teachers in each classroom, one or more teachers taught each lesson. Therefore, on any given day, we observed between one and three teachers enacting the strategies presented in the Institute (see Figure 1). Immediately after we watched the lesson, we rated the instruction based on how consistently the teacher engaged in each instructional practice and how consistently the students engaged in each student practice. For each practice, we evaluated each day of instruction based on the following ratings:

- "Consistently" [C]: the teacher/student engages in the target practice during the majority of possible opportunities during instruction. The practice is regularly and substantially reflected in the lessons.
- "Occasionally" [O]: the teacher/student engages in the target practice during some possible opportunities in the lesson, but does not do so consistently. There were some missed opportunities to engage in the practice.
- "Rarely" [R]: the teacher/student does engage in the target practice but the majority of opportunities in the lesson are missed. The practice is hardly reflected in the instruction.
- "None" [N]: the teacher/student does not engage in the target practice.

Due to the inferential nature of the rating categories, we conducted a calibration process with the raters to ensure a shared understanding of the meaning of each category. During the calibration process the raters independently rated and then compared ratings to refine how ratings were applied. In the process, we clarified that "possible opportunities" for a practice meant that the raters determined that the practice would have been productive at that point in the lesson. For example, typically when a student vocalizes a claim during a discussion but does not offer evidence to support the claim, there is an opportunity for the teacher to press the student for evidence. If the teacher does not press for evidence, that would be considered a missed opportunity. Because the measure required these types of inferences, we used a consensus rating method. Two members of the research team independently rated each day of the Practicum instruction. Disagreements of two steps apart or more (e.g., one rated "consistently" and the other rated "rarely") were resolved through discussion between raters and given consensus ratings. Single step disagreements were given a combination rating such as consistently/occasionally [CO]. Inter-rater agreement within one step was 96%. To facilitate analysis, we converted the ratings into a numerical 3-point scale (see Table 3). This process yielded one numerical rating for each practice on each of the eight days of Practicum instruction.

Table 3 Numerical rating scale

Practice Rating	Abbreviation	Numerical Value
Consistently	C	3
Consistently/Occasionally	CO	2.5
Occasionally	O	2
Occasionally/Rarely	OR	1.5
Rarely	R	1
Rarely/None	RN	.5
None	N	0

Results

Table 4 shows the average ratings of the teacher and student practices and the corresponding rating categories across the 8 days of the Practicum. These findings suggest that teachers tried out the main instructional practices communicated at the Institute, at least to some extent, during the Practicum instruction. In general, the teachers most consistently practiced the discourse moves during the Practicum instruction. The norms for discourse were also regularly reinforced although there was some variation from day to day, depending on the teacher. It is particularly important to introduce and reinforce norms for discourse during the beginning of the school year when the classroom culture is being established. Since the Practicum only spanned two weeks and the teachers were working with a set of students they had never met before, we would expect to see regular reinforcement of the discourse norms.

The instructional practices of charting student ideas and writing to support talk were practiced less consistently. This finding is not surprising given the nature of those practices. Teachers determine when it is strategic and useful to chart student ideas and ask students to write down their ideas. While potentially beneficial for supporting productive talk, we would not expect the practices to be present in connection with every classroom discussion.

The instruction engaged students in a variety of practices that were emphasized in the Institute. Students consistently made claims and supported those claims with evidence, and they occasionally used prior knowledge and new resources. The practices of critiquing one another's claims and revising claims were observed less often. It may be that these two practices, which entail following up on one's own claims or the claims of other students, are more difficult to learn than practices related to initially offering claims.

Table 4 Average ratings for each teacher and student practice

	Average Numerical Rating	Corresponding Rating*
TEACHER PRACTICES		
Norms for Discourse		
Language to disagree	1.9	O
Sentence frames	2.1	O
Active listening	2.4	CO
Speaking loudly	2.2	O
Wide participation	1.6	OR
Gestures	1.9	O
Discourse Moves		
Press	2.8	C
Revoice	2.8	C
Adding to	1.9	O
More ideas	2.1	O

Charting Student Ideas		
Recording ideas (non T-chart)	1.0	R
T-chart	1.1	R
Writing to Support Talk		
Writing activity	1.4	OR
Scaffolds for writing	1.0	R
Asking students to draw ideas	1.0	R
STUDENT PRACTICES		
Make initial claims/predictions	2.7	CO
Revise existing claims	0.9	R
Support claims with evidence	2.8	C
Critique claims	1.6	OR
Use prior knowledge & new resources	1.9	O

*Based on rounding to closest rating level

6 Classroom vignette: Dialogic nature of teacher and student practices

The analyses reported above indicate that teachers and students in the Practicum classrooms engaged in the majority of practices introduced in the Institute; however they do not illustrate the dialogic nature of the practices. In this section, we examine a vignette of a discussion in one of the teacher's Practicum lessons. We selected this particular instructional episode because it was a situation in which the discussion unfolded in an unexpected way, thus affording an opportunity to examine how a teacher adjusted her instruction based on what her students were saying in order to support productive classroom discourse. In addition, the episode is one that was discussed in the afternoon session on the following day. Thus it also provides an opportunity to consider how the afternoon coaching discussions were used to analyze teachers' use of discourse practices in their Practicum lessons.

The vignette is from classroom instruction that took place on Day 4 of the Practicum. Amanda,[2] a 4th grade teacher with three years of prior teaching experience, was one of three teachers who shared responsibility for instruction in one classroom. On this day, Amanda was teaching a lesson from the Practicum curriculum about ocean floors. The lesson was designed to engage students in argumentation about different claims about the topography of the ocean floor. Amanda showed her students four different possible representational silhouettes of the ocean floor (see Figure 2). She asked the students to select which representation they thought was most accurate. Unexpectedly, all of the students picked the same visual, the one with jagged underwater mountains, valleys, and deep canyons.

2 All names of teachers and students are pseudonyms.

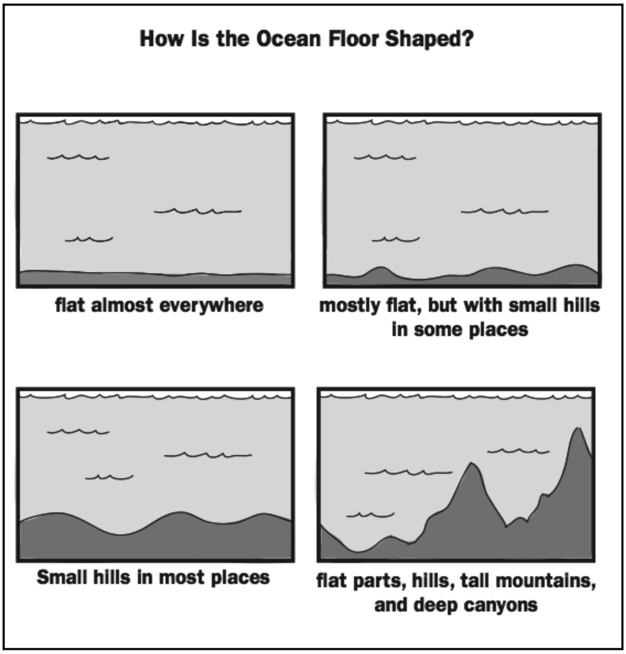

Figure 2 Ocean Floor Handout. Source: NOAA, 2011

Amanda had to quickly decide how to engage the students in productive scientific discourse since the consensus did not allow her to proceed with her plan of engaging them in a discussion about competing claims. She decided to ask the students for evidence that supported their selection. Several students suggested a variety of sources of evidence including television, movies, video games and one student's personal experience of going to a beach and stepping on a large, sharp rock in the water. Amanda was able to capitalize on their responses as an opportunity for discussion and asked the students which source of evidence they considered most reliable. The following is an excerpt from the lengthy discussion that followed:

Teacher: So out of the Discovery Channel, movie, video games, or Manuel's personal experience, which is the most reliable evidence and why? What do you think?

Alberto: I agree with Manuel because video games are fake. And some TV shows don't really show the real thing.

Teacher: So the two points that I just heard – Alberto, tell me if I'm saying what you said right. You said some TV shows aren't showing what's real, and video games are fake. [Alberto nods] Who would like to respond to what Alberto just said? Not to what I'm saying, but what do you think about his idea? I want you guys to talk to each other about what you think about what Alberto just said.

Blanca: I disagree with Alberto because in Discovery Channel when they go underwater they have cameras and you can see the ocean floor.

Teacher: Okay, so a response to Alberto or Blanca. To what one of them said.

Jose: I agree with Blanca because they can go in a submarine so much deeper.

Teacher: Okay, so what I hear Jose saying is that it's not that he doesn't believe what Manuel said, but the Discovery Channel brought cameras so if Manuel had brought a camera to the beach with him and he showed on video what he felt with his foot and what he saw with his eyes, then you would believe him just as much as you believe the Discovery Channel? Is that right? Is that what you said Jose? Okay.

In this excerpt, the students were making claims and supporting their claims with reasoning and evidence. The discussion was very fluid and animated as the students seemed to be very engaged by a topic that they found interesting and relevant. Many students wanted to participate in the discussion. While Amanda was primarily facilitating who talks next, she was also summarizing the different points being made in the discussion and pressing students for their reasoning. The students used discursive frames such as "I agree" or "I disagree," and they supported their claims with reasoning. Amanda guided the discussion and supported the students' discourse by paraphrasing points and encouraging widespread participation.

7 Video-based coaching discussion vignette

A systematic analysis of the full set of video-based coaching discussions is beyond the scope of this paper. However, to illustrate the nature of these discussions we present a vignette of the afternoon session during which Amanda, her colleagues, and their coaches discussed a video clip excerpted from this classroom episode.

Each afternoon during the Practicum, Amanda, her two co-teachers and their coach joined another pair of co-teachers and their coach for a video reflection discussion. On the day following Amanda's lesson about the ocean floor, it was her turn to share a clip for the discussion. In consultation with her coach, Amanda decided to share a clip from the discussion she facilitated with her students about the ocean floor topography. After introducing the clip and providing relevant context, Amanda posed the following question to frame the discussion:

I felt like they were starting to engage. This wasn't part of the lesson that was in the book, in the handbook, so it was just something that came up out of their own interests…. Based on what you're seeing in the video, what are the next steps that can be taken to help them to engage in a conversation that is authentic and student-generated versus what we've been doing? … We've been trying to do that but it's been more teacher – student – teacher – student. It's always very teacher directed. What can be done differently or in addition as next steps for student discussion?

Following a protocol designed to support video-based discussions, the teachers watched the video clip, spent time silently reflecting on what they saw, and then asked Amanda clarifying questions. For example, one teacher asked Amanda what she meant by "authentic." Amanda explained that she wanted to see students talking to each other in a discussion rather than just with the teacher, and she was interested in ideas about how to support this type of conversation in her classroom.

In the next phase of the video reflection protocol, the teachers shared observations about the video. During this phase, the presenting teacher's role is to listen and not contribute to the discussion. The teachers and coaches noted that the students were successful at following classroom discourse norms. They also discussed the affordances and limitations of allowing students to veer away from the intended topic of discussion. After exploring issues related to the substance of the video discussion, the teachers brainstormed ways to support student-to-student discussion (e.g., turning chairs to face each other, passing an object between students so they know whose turn it is to talk). The teachers seemed to agree that productive student-to-student discussion depended on the establishment of strong classroom norms that typically develop over time.

In the third phase of the protocol, the presenting teacher is given the opportunity to share her reflections and address any important points that arose in the discussion. Amanda explained that, in the case of the ocean floor discussion, she made a conscious decision to pause her initial plans for the lesson and to capitalize on the opportunity for authentic discussion. When all of the students agreed on the answer, she decided to press students for their reasoning and to explore their notions of reliability of evidence. She added that, in the future, she intends to do a better job at charting students' ideas and to draw attention to particular comments in order to highlight important student contributions.

The use of video in the afternoon component of the Practicum enabled teachers to reflect on their own instructional decisions and to receive input from their colleagues and coaches. As this example illustrates, the discussion of Amanda's video clip afforded her the opportunity to think about a variety of instructional options that might inform how she makes pedagogical decisions in the future. More generally, it provided an opportunity for all five teachers to consider ways of fostering student-to-student exchanges during class discussions. As a teacher, knowing when to insert oneself in the discussion and when to hold back is an important skill.

8 General discussion and implications

Engaging students in collaborative, critical science discourse is a challenging but important instructional practice. Despite research evidence for its importance, such discourse is absent in most science classrooms (Osborne, 2010). The pedagogical practices at the center of this project are intended to change this situation. They are aimed at encouraging students to express their ideas, supply evidence for their claims, and both build on and challenge one another's ideas. These discursive practices support the development of students' understanding of the science concepts (Chi, 2009). In order to encourage such dialogue, teachers must be responsive to what students are saying. They must productively insert themselves into the discourse in order to support students in reasoning with evidence (Resnick, Michaels, & O'Conner, in press).

The professional development model explored in this study was designed to support teachers in developing proficiency in instructional practices to foster productive classroom discourse. The innovative feature of the PD model was a Practicum experience in which teachers could practice instructional strategies introduced during a summer Institute, in a low-stakes classroom setting, and then have the opportunity for reflection, colleague feedback, and coaching. This study sought to better understand the relationship between the instructional practices communicated during the Institute and the practices that teachers tried out during the Practicum.

Our examination of the summer Institute identified the core teacher and student discursive practices that were emphasized by the PD leaders. Evidence from our analysis of the Practicum experience indicates that the teachers engaged in those practices in their Practicum classrooms, albeit some more consistently than others. As illustrated in the classroom vignette, the practices were used in a dynamic classroom context in which teachers needed to be responsive to their students. They had to decide when to press their students, when to link different students' comments, and how to support students in engaging directly with each other.

As with any sophisticated practice, developing proficiency in supporting scientific discourse and argumentation in an elementary school classroom takes time and experience. The summer Practicum afforded teachers the opportunity to begin to try out these dialogic practices with students in a real classroom context, an important component of science professional development (Putnam & Borko, 2000; Wilson, 2013).

Furthermore, the video-based discussions with their coaches and colleagues provided the reflective space for teachers to critically examine their instructional decisions and to explore alternatives in a safe and supportive environment. Video offered a medium for the teachers to share instructional episodes and process them together in productive ways (Jacobs, Borko, & Koellner, 2009; Sherin, 2004). By teaching in the morning and engaging in video discussions in the afternoon, the teachers who participated in this Academy had the opportunity for rapid cycles of planning, teaching, reflection, and modifying instruction for the next day.

While the Practicum may be a valuable space for trying out new instructional practices, the ongoing impact of the professional development can only be observed in the teachers' regular classrooms. In their own classrooms, teachers have more time to practice these pedagogical strategies and to establish a classroom culture that is so crucial for this type of instruction, and students have more time to engage in collaborative, critical discourse. Also, in the Academy PD model, the Follow-up sessions provide an opportunity for additional guidance and support as the teachers incorporate these practices into their instruction, again using video from their classrooms as a springboard for discussion and collaborative analysis. As part of the larger research project, we are examining whether these practices do, in fact, get carried into the teachers' classrooms. We will compare the classroom practices of teachers who attended the summer Institute, Practicum, and Follow-up sessions with teachers who attended only the Institute and Follow-up sessions. We will also compare students' science learning in these teachers' classrooms. These comparisons will provide evidence as to the effectiveness of the Academy with and without the Practicum opportunity for developing teachers' instructional practice.

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Eric Berson,
Stanford Graduate School of Education, 485 Lasuen Mall, Stanford, CA 94305-3096, USA,
eberson@gmail.com

Hilda Borko,
Stanford Graduate School of Education, 485 Lasuen Mall, Stanford, CA 94305-3096, USA,
hildab@stanford.edu

Susan Million,
Stanford Graduate School of Education, 485 Lasuen Mall, Stanford, CA 94305-3096, USA,
million@stanford.edu

Edit Khachatryan,
Stanford Graduate School of Education, 485 Lasuen Mall, Stanford, CA 94305-3096, USA,
edit@stanford.edu

Kerri Glennon,
Stanford Graduate School of Education, 485 Lasuen Mall, Stanford, CA 94305-3096, USA,
kglennon@stanford.edu

Video Clubs: EFL Teachers' Selective Attention Before and After[1]

Eva Minaříková, Michaela Píšová, Tomáš Janík, Klára Uličná
Masaryk University, Faculty of Education

Abstract: The paper aims to introduce results of a study of the effects of participation in video clubs on EFL (English as a Foreign Language) teachers' selective attention. It is a part of a larger project concerned with EFL teachers' professional vision. The paper introduces the theoretical background of study on teachers' professional vision and selective attention and the rationale of video clubs used specifically for EFL teachers. 11 EFL teachers participated in this year-long study and attended video club meetings that aimed to foster their professional vision for conscious development of pupils' communicative competence. They were interviewed at the beginning and at the end of the programme; video sequences of their own teaching and of other teacher's teaching were used as prompts. The transcribed data were analysed using a theory-driven system of categories describing the areas of teachers' selective attention (i.e. aims, context, content, pupil/s, teacher, process). The results suggest that after participating in video clubs the teachers paid more attention to aims and content, and less to the teacher. The results for the category of pupil(s) differed for the own/other video sequence. As the development of communicative competence represents the ultimate goal of EFL teaching, it is encouraging that after the intervention the teachers' comments were more aim and content oriented.

Keywords: professional vision, selective attention, video in teacher education, video clubs, English as a foreign language, teacher education, teacher professional development

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It is a natural human characteristic that we do not attend to all the stimuli our senses can detect. This phenomenon is referred to as selective attention. In studies on professions and their characteristics, selective attention is often connected to the concept of professional vision which has been described by Goodwin as "socially organized ways of seeing and understanding events" (1994, p. 606). In teacher research, professional vision has been linked to teacher expertise (comp. Jacobs, Philipp, & Sherin, 2011, p. xxv) and its changes to changes in teacher practices (van Es & Sherin, 2010). There are numerous studies regarding its nature and development, mainly through the use of video in different formats (Borko et al., 2008; Brophy, 2004; Janík et al., 2009; Píšová, 2005). However, these studies and research projects focus mostly on the area of mathematics and science education (e.g. Sherin, Jacobs, & Philipp, 2011). Teachers, however, are not a homogenous group and it is often pointed out that teachers of different subjects form so-called subcultures (Grossman, 1995). It has also been shown that the subjects the teachers

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teach influence their professional vision (Blomberg, Stürmer, & Seidel, 2011). To fill the existing gap in research and our knowledge, our project focuses on the use of video for developing professional vision of in-service teachers of English as a foreign language (EFL), specifically in the context of video clubs. In this particular study we will focus on teachers' selective attention, i.e. what they pay attention to when commenting on classroom videos and if and how this changes after their participation in video clubs.

1 Professional vision and selective attention

When defining professional vision, two components are usually mentioned (Sherin, 2007, p. 384; Seidel et al., 2010, p. 297) – selective attention[2] and knowledge-based reasoning. Selective attention can be defined as the process of identification of situations and events that are, from the professional point of view, instrumental for the success of pedagogical action (Seidel et al., 2010, p. 297). Knowledge-based reasoning represents the processes of making sense of situations and thinking about them, and presupposes certain knowledge (Seidel et al., 2010) or understanding (Sherin, 2007). These two components of professional vision are however interrelated and cyclical. Teachers direct their attention based on their reasoning and reason about things they give attention to (Sherin, Jacobs, & Philipp, 2011, p. 5).

Selective attention refers to noticing certain phenomena in a classroom situation whilst not attending to others. In psychological terms, attending to means becoming aware of stimuli (e.g. Eysenck & Keane, 1995, p. 95). Attention is paid only to salient stimuli while irrelevant information is discarded. Without this process, people would become overwhelmed with stimuli. In teacher research, studies of selective attention (noticing; comp. Sherin, Jacobs, & Philipp, 2011, p. 5) differ. They vary in terms of whether they limit their scope to focus on a particular aspect of noticing (e.g. student thinking; Jacobs et al., 2011) or explore teachers' noticing in its entirety (e.g. Star et al., 2011). Studies also vary in their approach to investigating selective attention. Some of them adopt the exploratory (descriptive) stance by "letting teachers notice" events (usually by means of an interview or a discussion stimulated by a video recording[3]) and then analysing what has been addressed. On the other hand, some studies start by defining, based on previous research, what should be attended to and then check if and how teachers reason about these phenomena while not including other aspects (usually by means of a scale-based questionnaire; see for example Seidel et al., 2010, pp. 299–300).

[2] The term noticing is sometimes used instead of selective attention. Some authors adopt, however, a broader definition of noticing that includes also knowledge-based reasoning processes (comp. Sherin, Jacobs, & Philipp, 2011, p. 9). As we want to focus only on the "what" teachers notice, we shall use the term selective attention.

[3] The mentioned methods belong to the most used. However, new approaches are being developed at the moment, such as the use of eyetracking for understanding teachers' visual processing of classroom situations (e.g. Wolff, 2014).

As there is a lack of studies focusing on EFL teachers' selective attention, we adopt the exploratory approach and aim to investigate their noticing in its entirety. That is also why, for the purpose of this paper, we do not focus on knowledge-based reasoning and will address the issue elsewhere. We ask teachers to comment on classroom videos and then analyse their responses using broad categories describing the common themes in the study of teaching and learning (see below). On the other hand, in the intervention part of our study we adopt the "prescriptive" stance guiding the participants to notice specific features of the situations and reason about them. This approach is common in many pre-service and in-service teacher education programmes focusing on the development of professional vision and, what we consider particularly important, meets the ethical requirements posed on teacher research. To name a few examples of such interventions with different foci, Sherin and van Es (2009) focused on helping the teachers identify and interpret student ideas about mathematics, whereas Gold, Forster, and Holodynski (2013) focused on assisting pre-service teachers in noticing features of classroom situations salient for effective classroom management. The next chapter will introduce the structure of our intervention as well as its particular aim.

2 Video clubs

Our video clubs were inspired mainly by professional development programmes from the field of mathematics teacher education (video clubs, Problem Solving Cycle; see below). However, the focus was strictly domain-specific. As the main aim of English as a foreign language lessons and teaching is the development of pupils' communicative competence, the intervention focused on a specific aspect of EFL teachers' professional vision – the attention to conscious development of pupils' communicative competence. Communicative competence (see CEFR, 2001; Bachmann, 1990) has been the leading concept in EFL teaching since 1970s (Larsen-Freeman & Freeman, 2008, Kumaravadivelu, 2006). It provides the goal for language learning and as such guides language teaching, provides framework for assessing pupils' progress and can also be used to evaluate instruction. This is why we believe EFL teachers should possess professional vision for development of pupils' communicative competence. This would allow them to plan instruction with relevant goals (professional vision in pre-active phase), see, attend to, and respond to situations appropriately (treatment of mistakes, approach to individual students, etc.) and be able to evaluate their own actions within this framework. Thus, a greater integration of instructional aims and content into teachers' considerations of teaching and learning was the aim of our intervention.

There are many models of communicative competence (e.g. Bachmann, 1990; Canale & Swain, 1980; CEFR, 2001; Savignon, 1983). In our approach we draw on the conceptualization by Van Ek (1986)[4] that posits that in order to develop learners'

[4] We did not make use of the *Common European Framework* (CEFR) conceptualization as it guides the curricular documents in the Czech Republic and the teachers work with it on a daily basis.

ability to communicate in a foreign language, we need not only to (a) teach vocabulary, grammar or pronunciation (*linguistic competence*), but also help the learners (b) to interpret and use the language forms appropriately to the situation (*socio-linguistic competence*), (c) to form coherent utterances and understand communication patterns (*discourse competence*), develop (d) their ability to compensate the gaps in their knowledge (*strategic competence*), and assist them in (e) getting acquainted with the socio-cultural context (*socio-cultural competence*). We should also not forget (f) to foster their overall ability to participate in social situations (*social competence*; see Van Ek, 1986, pp. 30–31). This model guided our intervention organized in the form of video clubs.

In order for the concept of communicative competence to become a part of teachers' professional knowledge (that drives professional vision), its integration into their knowledge structures through lived experience and its reflection was vital. That is why, besides the intervention being inspired by videoclubs (van Es & Sherin, 2008), we also integrated some elements (activity design – see below) of the Problem Solving Cycle programme (Koellner et al., 2007). By a video club we mean a group of teachers (three or four) and facilitators from the university (two) that met regularly to discuss classroom videos. Each video club met five times throughout the year. Besides the meetings, the teachers were videotaped four times and had to complete given assignments. Each video club meeting lasted approximately 90 minutes. The facilitators were present and actively involved in the discussion. The meetings were videotaped and a voice recorder was used to capture quieter exchanges. As the groups were small (three to four participants), all the participants always worked together. Despite the common format (organized around watching classroom videos), each session was specific. The first meeting focussed mainly on breaking the ice among the participants and getting to know each other. Even though the teachers had been videotaped once before the first meeting, the videos used in this session did not depict any of the current participants but portrayed classroom video sequence from EFL lessons at different types of schools. The facilitators participated in the discussion but did not steer participants' attention in any way. During the second meeting, two video sequences (approx. 3–5 minutes) from participants' lessons were shown (selected by the facilitators in cooperation with the teachers in question). Gradually, the facilitators started asking questions about the aims and the content of the lesson. The session finished with a facilitator initiated discussion regarding communicative competence and activities and tasks that aid its development. For homework, the participants were asked to read a short handout on communicative competence and its components and different types of communicative and pre-communicative activities in EFL lessons (cf. Littlewood, 2004). At the start of the third meeting, the participants were asked for feedback and a short discussion ensued regarding the theoretical input. One of participant's videos was

We believed it could be perceived as criticism of their work. We thus chose Van Ek's approach that is related to CEFR, relatively simple and, in our opinion, easy to grasp, and relevant for learners' needs.

then watched and discussed with facilitators steering attention again towards developing communicative competence. At the end of the session, the teachers were asked to design an activity together that would be communicative in nature and could be used in their classes. They were asked to use this activity in the following videotaped lesson in a version modified to the level of communicative competence of their learners as well as to the context (and provide a short written overview of changes they had to make in order to adapt the activity). Sequences depicting these activities were shown and analysed at the fourth meeting. The fifth meeting included discussions of more video sequences from participants' lessons with no specific focus and the whole video club experience was summarized. An overview of the structure of video clubs is shown in Figure 1.

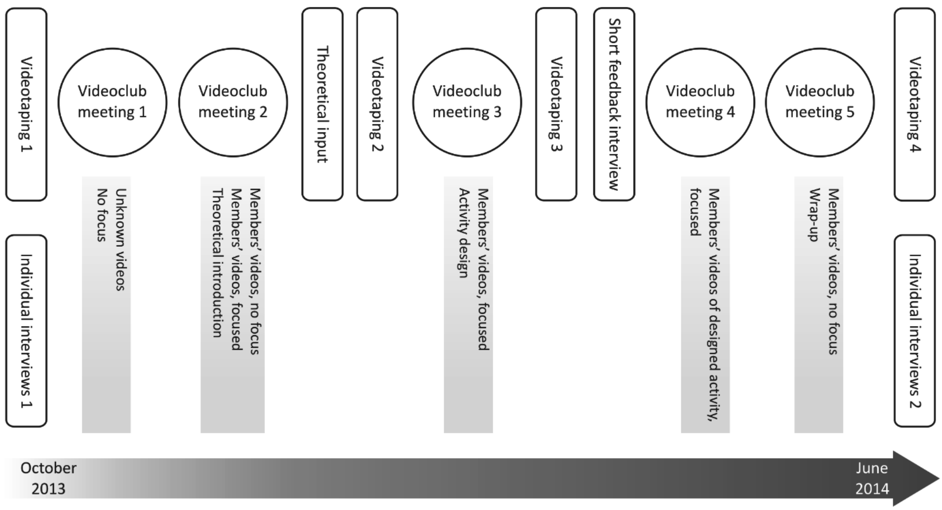

Figure 1 Video club design

There were altogether three groups of teachers participating in video clubs in 2013/2014. Two of them included teachers from different schools. In one group (B), some of the teachers had known each other beforehand, in the other (A) the teachers had never met. These video clubs took place at the university. The third group (school-based) comprised four colleagues from one school who had decided together that they would participate. The school provided premises where the video club was organized.

3 Research aims and questions

In our research project we are concerned with EFL teachers' professional vision and the possibilities for its development through video clubs. In this particular study we focused on if and how selective attention (i.e. the "content" of professional vision) changes after teachers' participation in video clubs (that focused on the conscious development of pupils' communicative competence). The research questions are as follows:

Was there a difference in selective attention (i.e. a component of professional vision) when practising EFL teachers observed a video sequence of a classroom situation before and after their participation in video clubs?

- Was there a difference in the absolute occurrence of the individual categories of selective attention (see Section 4.3)?
- Was there a difference in the relative occurrence of the categories of selective attention (for individual teachers)?

4 Methods

4.1 Participants

This study is a part of a larger project. Within this project, the data was first collected through an online video-questionnaire based survey. Schools from the Southern Moravian region were randomly selected and contacted. In order to be included in the research sample, the teachers needed to be qualified to teach English as a foreign language[5]. When selecting participants for video clubs, convenience sampling was used. After the completion of the online questionnaire, all the teachers were offered to participate in video clubs. Eleven teachers agreed to take part and were divided into three groups that met throughout the year (see above). Table 1 gives detailed information about the research sample. Even though the original survey sample included teachers from around the Southern Moravia region, only teachers from Brno, where our research institution is based, participated in video clubs.

4.2 Data collection

The data was collected within the school year 2013/2014. Two individual interviews were conducted with each participant – one before the first video club meeting, the other after the last meeting. Each interview followed a videotaping of the participant's lesson and was based on two video sequences. The first one was a two and a half minute long sequence from a previous video study that depicted a situation from an EFL lesson (7th grade) where the teacher works with the whole class and

[5] In the Czech context this means holding a Master's degree in teaching English at (lower) secondary schools or holding a Master's degree in teaching at primary schools with specialization in EFL.

Table 1 Participants

Teacher	School	Grade[6]	Years of teaching experience	Qualified for teaching	Video club	Experience with using video in PD[7]
T1	A	5	9	English + arts	B	No
T2	B	9	9	English + chemistry	B	Yes
T3	C	3	4	primary	A	Yes
T4	D	7	11	English + Czech	B	No
T5	E	5	2	primary	SB	No
T6	E	2	2	primary	SB	Yes
T7	F	7	2	English + Czech	A	No
T8	G	9	13	English + Czech	B	No
T9	H	5	17	English	A	No
T10	E	3	17	English + special education	SB	Yes
T11	E	7	1	English	SB	Yes

elicits responses regarding the pictures in the textbook from the pupils. Both the teacher and the pupils are visible in the sequence. This video sequence was used in both the pre- and the post-interview (further on labelled as "other"). [67]

The second video sequence was selected from the videotaped lesson[8] (further on labelled as "own"). Such sequences were chosen that showed interaction between the teacher and the pupils where both were visible and audible. If possible, instances of "genuine communication" were selected (rather than e.g. grammar exercises or drill sessions).

During the interview, the teachers watched each video sequence twice. First as a whole, then they took control and could stop it at any point. The opening task was "could you please comment on the video sequence". No further prompts were given. The interview continued until they stated they have nothing more to say. On average the interviews lasted about 30 minutes.

4.3 Data analysis

The data was analysed using a system of categories for describing selective attention derived from basic categories related to teaching and learning. These were: teacher, pupil(s), aims, content, process, and context (see Table 2). These are the main didactic categories covering the different aspects of teaching and learning (for Czech

6 Each teacher chose one class to have recorded which remained constant throughout the whole project. Grade refers to the grade of this class.

7 Professional development.

8 The videotaping and the interview usually took place on the same day.

Table 2 System of categories for describing teachers' selective attention

	Description	Example
Teacher	The statement focuses on the teacher (in the video sequence) – his/her actions, knowledge, thinking etc.	*I liked the way the teacher used gestures, her demeanour; she seemed really nice to me. I liked that.* (T3_post_other)
Pupil(s)	The statement focuses on a pupil or pupils (either in the video sequence, in general or the respondents' own pupils) – their actions, knowledge, thinking etc.	*You can see the kids are already on holiday, distracted.* (T9_post_own)
Aims	The statement focuses on the aims, either general aims of (language) education or (supposed) aims of the activities portrayed or aims intended by the teacher in the video sequence.	*The activity was meant for the kids to reinforce their knowledge of prepositions, those basic ones.* (T8_post_own)
Content	The statement focuses on the content (to be learned). This includes English/Czech as a medium of instruction as in language teaching the language used provides (or does not provide) input for the learners.	*Well, the English is quite..., sometimes there is is instead of are, but anyway.* (T6_pre_own)
Process	The statement mentions the actions being carried out – either with direct connection to their agents or without it.	*And here she did the revision; quite important and definitely valuable.* (T7_post_other)
Context	The statement includes a reference to the context and conditions of the situation, ranging from broad issues (such as the state of society) to classroom context (classroom layout and equipment) and didactic media used (textbook, whiteboard etc.).	*There was a map of England, or Great Britain; that is a good teaching aid, too.* (T7_post_other)

didactic tradition see Skalková, 2007; for the continental tradition see for example Berliner Model – Heimann, Otto, & Schulz, 1969). Referring to the perception of professional vision as a knowledge-based phenomenon, these categories represent dimensions of complex professional knowledge for teaching, their synergetic effect may be linked to what Shulman labelled as pedagogical content knowledge (1986, 1987; Kansanen, 2009). Compared to other studies of professional vision, resp. selective attention, there is close resemblance with the inductively created system of categories in the research by van Es and Sherin (2008): they identified two dimensions of the content of professional vision, the Actor (student, teacher, or other) and the Topic (mathematical thinking, pedagogy, climate, management, or other). Similarly, there are close links to the categories deployed in the research by Seidel et al. (2007).

First, the data from each participant were divided into four parts – comments on other video from pre-interview, comments on own video from pre-interview, comments on other video from post-interview, and comments on own video from post-interview. Afterwards, idea units, i.e. such parts of the comment that expressed one consistent and clearly separable idea (comp. van Es & Sherin, 2006, p. 127; Jacobs & Morita, 2002, p. 159) were identified in the comments. Further on we will call these idea units segments. Each segment was then assigned to one or more categories. We decided not to make the categories mutually exclusive as it has been shown by teacher knowledge research that teachers perceive classroom events and think about them in integrated patterns building on an organised knowledge base (Glaser & Chi, 1988; Fenstermacher, 1994; Bransford et al., 2000, etc.). Therefore it was expected that while watching the sequences teachers will be able to activate these contextualised patterns (Putnam & Borko, 2000; Seidel et al., 2011; Píšová & Janík, 2011). Further on we shall call one occurrence of one category a *code*. Thus each part of an interview can be described by two numbers – the number of segments (ideas) and the number of codes (occurrences of categories). These are available in Table 3.

Table 3 Number of segments and codes in interview parts

Teacher	Video	Pre-Segments	Pre-Codes	Post-Segments	Post-Codes
T1	own	8	21	11	30
	other	7	19	5	12
T2	own	20	45	7	21
	other	14	39	7	24
T3	own	9	23	8	23
	other	12	26	8	22
T4	own	11	32	26	87
	other	16	47	13	44
T5	own	14	41	11	32
	other	9	24	4	10
T6	own	11	22	11	28
	other	12	37	8	20
T7	own	7	16	17	43
	other	7	20	15	28
T8	own	27	79	18	50
	other	11	34	5	11
T9	own	10	33	13	29
	other	21	51	10	30
T10	own	6	18	12	31
	other	10	28	8	20
T11	own	8	22	10	24
	other	8	15	8	26
Total		258	692	235	645

The data was coded using MAXQDA software. Two researchers first fine-tuned their understanding of the category system by jointly coding 11 interview parts (pre_other). Afterwards, the intercoder agreement was checked on three interview parts. The coders agreed 80% of the time. Further discussions ensued to resolve disagreements. To ensure the greatest degree of objectivity, the rest of the data was coded jointly by the two researchers. The obtained numbers of codes were further analysed using statistical procedures (see below).

5 Results

This chapter will be structured according to the research questions. First, we will look at the overall difference in occurrence of categories (codes) before and after participation in video clubs, then at the difference between pre and post-interview for individual teachers. In each of these areas we will look at the results in general and also separately for the two conditions (other video vs. own video). However, it is not our aim here to investigate the differences between comments on the video of own teaching or another person's teaching (cf. Sherin & van Es, 2009; Seidel et al., 2011). The purpose of using these two types of video was to investigate whether video club has the potential to change teachers' professional vision in its different manifestations.[9]

5.1 Was there a difference in the absolute occurrence of the individual categories of selective attention?

In order to respond to the first research question quantitative data analysis was deployed. Firstly, simple descriptive statistical analysis was conducted based on absolute occurrence of the categories identified in the interviews before and after the video clubs. Comparable values across the six categories are provided in Table 4, visualisation of the results in the form of a graph is offered for illustration in Figure 2.

Table 4 Total occurrence of the categories pre and post video clubs

	Aim	Context	Content	Pupil(s)	Teacher	Process	Total
pre	13	51	102	175	146	205	692
post	31	63	130	168	84	169	645

The analysis showed change in the occurrence of categories in teachers' comments on the observed video sequences before and after the video clubs: while the number of codes related to the categories of aims and content increased, there was a decrease of attention to the teacher and also to the procedural aspects of tuition.

[9] Professional vision can be manifested in different contexts – when teachers observe other teachers' lessons, when they observe a videotape of their own teaching. Most importantly, it is manifested in the act of teaching itself. However, professional vision in action is difficult to research (comp. Sherin et al., 2008).

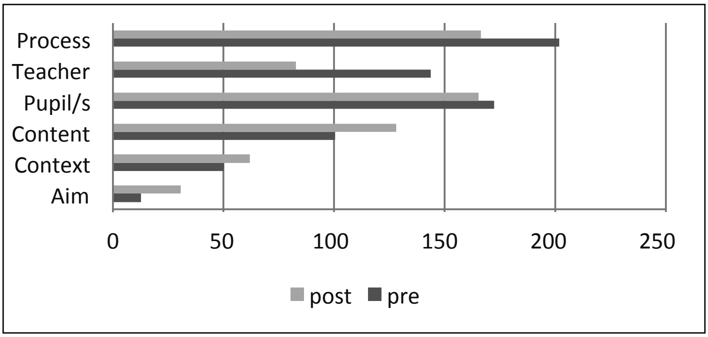

Figure 2 Total occurrence of the categories pre and post video clubs

The above analysis builds on overall data, i.e. on teachers' comments both on the video of own teaching and another person's teaching. Though we did not focus on the differences between them in this study, it was vital to find out whether the overall results were not influenced by the fact that both sets were included in the analysis. In other words, whether the above mentioned changes reflect differences in teachers' selective attention in general, no matter if watching own teaching performance or somebody else's. Further on, the results for comments on other and own video sequences before and after the video clubs are provided in the same format (number of occurrences; see Tables 5 and 6, Figures 3 and 4).

Table 5 Occurrence of categories in comments on other video sequence in pre- and post-interviews

	Aim	Context	Content	Pupil/s	Teacher	Process	Total
pre	4	32	54	79	69	102	340
post	14	24	49	57	26	77	247

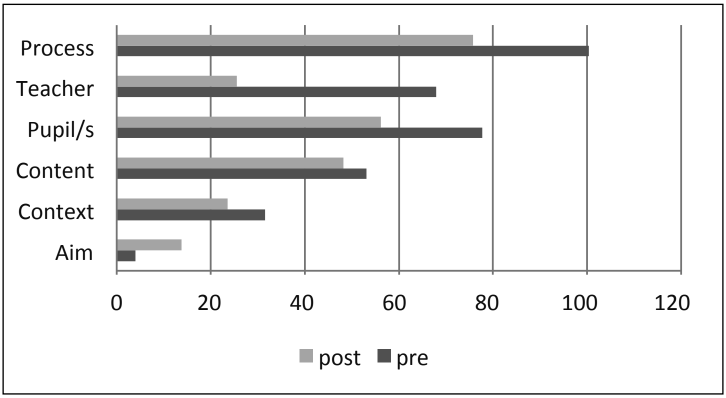

Figure 3 Occurrence of categories in comments on other video sequence in pre- and post-interview

From Table 5 it is evident that in the comments on other video the absolute occurrence increased only in the category aim. Content and context were mentioned slightly less. The most prominent decrease is evident in categories process, pupil(s), and especially teacher.

Table 6 Occurrence of categories in comments on own video sequence pre and post video clubs

	Aim	Context	Content	Pupil/s	Teacher	Process	Total
pre	9	19	48	96	77	103	352
post	17	39	81	111	58	92	398

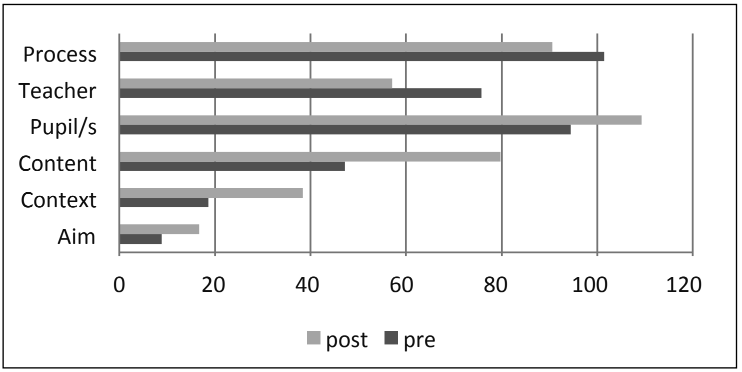

Figure 4 Occurrence of categories in comments on own video sequence in pre- and post- interviews

The results for the differences in the comments on one's own teaching performance show a slightly different picture. There was a decrease in the occurrence of two categories (process and teacher), and increase in all the other categories.

From Tables 5 and 6 it is obvious, that the overall number of codes decreased after the participation in video clubs. However, the decrease was more prominent in the other video comments. Thus we need to be careful when interpreting the results expressed by absolute numbers. In the next part, we are going to explore the results in relative numbers (percentages) − that is how much of participants' comments referred to the individual categories.

5.2 Was there a difference in the relative occurrence of the categories of selective attention (for individual teachers)?

There are more reasons for posing the second research question. Firstly, individual teacher developmental trajectories help us detect whether there were any extreme cases that would influence the overall results; that is, in a way, to validate the above response to the first research question. Secondly, we wanted to find out whether any groups of teachers in terms of how their professional vision, resp. selective attention, changed as a result of participation in the video clubs may be identified. This might indicate the procedural validity of video clubs; we find it especially important as the teachers are to a great extent the designers of the video clubs, their decisions and needs may strongly shape the content of discussion on the video sequences in their groups (see the description of video clubs in 2). It is important to learn whether any significant differences may be caused by the participation in a specific group. Last but not least, as it is planned to run the video clubs as a means for promoting (English language) teacher professional development as one of the *Didactica Viva* scheme activities, i.e. within the framework of pregraduate teacher education as well as CPD courses for practising teachers, a deeper insight into individual differences among teachers is a sine qua non.

Quantitative analysis was again considered appropriate as we search for the changes in the frequency of occurrence of comments in individual categories. However, as the focus is on individual teachers', relative occurrence of codes must be considered. Relative figures (percentages) stand for the proportions of attention individual teachers paid to individual categories while commenting on the video sequences. As the overall results indicated a distinction between selective attention when observing own or other video sequence in the category of pupil(s), the analysis was conducted separately for these two sets of data. Table 7 presents the results of the analysis, further visualisation is provided in Figures 5 and 6 in the form of radar charts.

When reading Table 7 vertically, the overall view of the columns with arrows indicating increase/decrease in individual categories as well as the graph shapes depicted in the graphic presentation of results in Figures 5 and 6[10] obviously correspond to the results obtained in the first analysis. Thus, they prove shifts in teachers' selective attention, namely higher frequency of occurrence of the categories of aims, as well as context and content balanced by the decrease in the categories of teacher and process. As regards the category of pupil(s), the difference in shifts between own and other video is also clearly visible.

As regards statistical significance of the changes we used the data from Table 7 to compare the results in the individual categories pre and post video clubs (see Table 8). Due to the nature of the data, we ran non-parametric Wilcoxon Signed Ranks Test. For the other video, there was a significant increase in the category of aims ($Z = -2.366$, $p < 0.05$) and significant decrease in the category of teacher ($Z = -2.934$, $p < 0.05$). In the remaining categories minor changes can be observed, specifically an increase of attention to the category of content.

The test showed that the changes in the content of teachers' selective attention related to their own teaching were statistically significant in three categories: those of content ($Z = -2.134$, $p < 0.05$), teacher ($Z = -2.402$, $p < 0.05$), and process ($Z = -2.223$, $p < 0.05$). While the frequency of comments on content increased in a significant way, noticing of aspects of teacher performance and of instructional processes was significantly less represented after the video clubs. Minor tendencies in the sense of growing attention were observed in the categories of aims and pupil(s).

[10] These graphs illustrate the changes. Their compact nature allows for viewing of the data from Table 7 in context of all participants and categories at a glance. Concrete numbers for individual participants are available in Table 7.

Table 7 Differences in the relative occurrence of the individual categories for individual teachers (in %)

		Aims			Context			Content			Pupil(s)			Teacher			Process		
Teacher		Pre	Post		Pre	Post		Pre	Post		Pre	Post		Pre	Post		Pre	Post	
T1	Own video	0.00	3.33	↑	19.05	10.00	↓	4.76	13.33	↑	33.33	30.00	↓	9.52	16.67	↑	33.33	26.67	↓
T2		0.00	0.00	→	2.22	4.76	↑	11.11	33.33	↑	33.33	23.81	↓	15.56	19.05	↑	37.78	19.05	↓
T3		4.35	4.35	→	4.35	4.35	→	8.70	21.74	↑	21.74	34.78	↑	34.78	13.04	↓	26.09	21.74	↓
T4		3.13	8.05	↑	12.50	14.94	↑	6.25	21.84	↑	28.13	24.14	↓	21.88	12.64	↓	28.13	18.39	↓
T5		0.00	9.38	↑	4.88	6.25	↑	4.88	9.38	↑	31.71	25.00	↓	29.27	21.88	↓	29.27	28.13	↓
T6		13.64	7.14	↓	4.55	3.57	↓	18.18	21.43	↑	22.73	35.71	↑	9.09	7.14	↓	31.82	25.00	↓
T7		0.00	0.00	→	6.25	6.98	↑	0.00	25.58	↑	25.00	27.91	↑	31.25	20.93	↓	37.50	18.60	↓
T8		1.27	4.00	↑	3.80	14.00	↑	21.52	16.00	↓	22.78	24.00	↑	25.32	16.00	↓	25.32	26.00	↑
T9		3.03	0.00	↓	3.03	6.90	↑	24.24	20.69	↓	24.24	34.48	↑	21.21	10.34	↓	24.24	27.59	↑
T10		0.00	3.23	↑	0.00	9.68	↑	16.67	25.81	↑	33.33	25.81	↓	22.22	12.90	↓	27.78	22.58	↓
T11		9.09	0.00	↓	4.55	12.50	↑	18.18	16.67	↓	27.27	33.33	↑	13.64	8.33	↓	27.27	29.17	↑
T1	Other video	0.00	0.00	→	21.05	16.67	↓	10.53	25.00	↑	31.58	16.67	↓	10.53	8.33	↓	26.32	33.33	↑
T2		5.13	12.50	↑	12.82	16.67	↑	23.08	20.83	↓	25.64	20.83	↓	7.69	4.17	↓	25.64	25.00	↓
T3		0.00	13.64	↑	11.54	9.09	↓	15.38	22.73	↑	26.92	18.18	↓	19.23	13.64	↓	26.92	22.73	↓
T4		2.13	6.82	↑	8.51	9.09	↑	14.89	15.91	↑	25.53	25.00	↓	19.15	13.64	↓	29.79	29.55	↓
T5		0.00	0.00	→	12.50	20.00	↑	20.83	20.00	↓	20.83	20.00	↓	12.50	0.00	↓	33.33	40.00	↑
T6		0.00	0.00	→	10.81	10.00	↓	16.22	15.00	↓	16.22	30.00	↑	27.03	10.00	↓	29.73	35.00	↑
T7		0.00	0.00	→	0.00	3.57	↑	20.00	14.29	↓	20.00	25.00	↑	30.00	10.71	↓	30.00	46.43	↑
T8		0.00	18.18	↑	11.76	9.09	↓	17.65	36.36	↑	26.47	18.18	↓	17.65	0.00	↓	26.47	18.18	↓
T9		1.96	3.33	↑	7.84	13.33	↑	11.76	23.33	↑	19.61	23.33	↑	25.49	10.00	↓	33.33	26.67	↓
T10		0.00	5.00	↑	0.00	0.00	→	10.71	25.00	↑	32.14	25.00	↓	25.00	10.00	↓	32.14	35.00	↑
T11		0.00	3.85	↑	6.67	7.69	↑	13.33	15.38	↑	6.67	23.08	↑	33.33	19.23	↓	40.00	30.77	↓

Note. White rows – video club SB; dark grey rows – video club A; light grey rows – video club B.

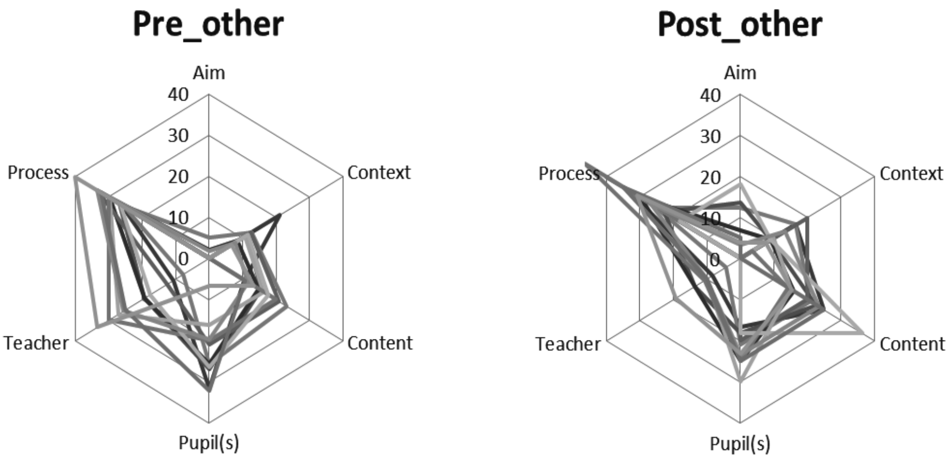

Figure 5 Relative occurrence of the individual categories in individual teachers' comments other video sequences in pre- and post-interviews

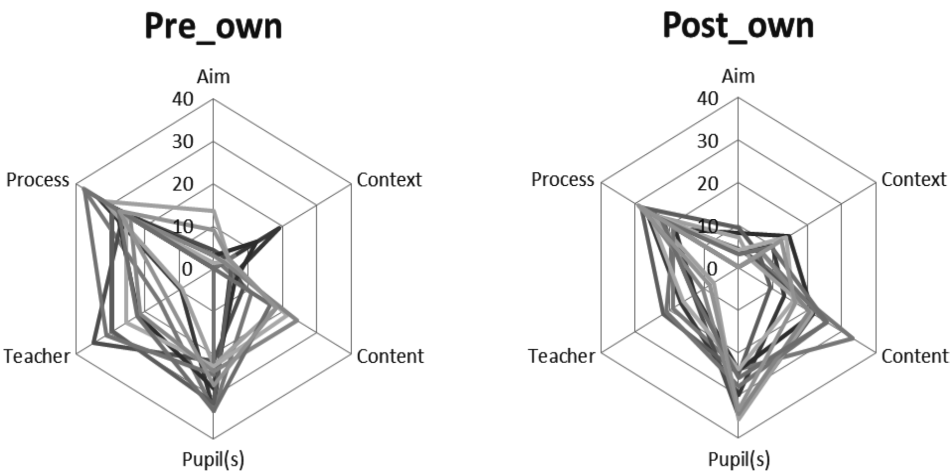

Figure 6 Relative occurrence of the individual categories in individual teachers' comments on their own video sequences in pre- and post-interviews

Table 8 Comparison of relative occurrence of individual categories pre and post video clubs

	Own				Other			
	Pre M(SD)	Post M(SD)	Z	Asymp. Sig. (2-tailed)	Pre M(SD)	Post M(SD)	Z	Asymp. Sig. (2-tailed)
Aim	3.14(4.47)	3.59(3.44)	−0.420a	0.674	0.84(1.64)	5.76(6.37)	−2.366a	0.018*
Context	5.93(5.34)	8.54(3.96)	−1.784a	0.074	9.41(5.97)	10.47(5.89)	−0.866a	0.386
Content	12.23(7.94)	20.53(6.58)	−2.134a	0.033*	15.85(4.20)	21.26(6.44)	−1.600a	0.110
Pupil(s)	27.60(4.64)	29.00(4.81)	−0.445a	0.657	22.87(7.32)	22.30(3.95)	−0.445b	0.657
Teacher	21.25(8.61)	14.45(4.91)	−2.402b	0.016*	20.69(8.25)	9.07(5.83)	−2.934b	0.003*
Process	29.87(4.67)	23.90(4.01)	−2.223b	0.026*	30.33(4.24)	31.15(8.04)	−0.089a	0.929

Note. a – based on negative ranks; b – based on positive ranks. Asterisk denotes statistically significant results ($p < 0.05$).

These results in general correspond to the findings of the study by Seidel et al. (2011) who found some indication that the video observation may to a certain extent activate prior knowledge about teaching and learning in teachers, so that the viewing is enriched or affected. However, our analysis did not reveal dramatic differences between the orientation (increase – decrease) of changes in selective attention displayed before and after the video clubs when watching other or own video in any of the categories, it was rather the extent of the change that differed in the two sets of data. Thus, it may be concluded that the content of teachers' selective attention changed after participating in the video clubs, the occurrence of the categories of aims, content (and in a less obvious way also context) increased, while those of teacher and process decreased. No major change was identified in the category of pupil(s), though a more detailed look indicates that noticing here differed when watching other and own video sequences.

In interpreting the results, however, we were here concerned with the information provided when reading Table 7 vertically, or when analysing individual graphic representations of the shifts. The analysis proves that though the teachers shifted in what they noticed in slightly different ways, there were no extreme cases that would outbalance the overall results in one way or another. Furthermore, the analysis did not reveal any significant commonalities in the shifts of selective attention, the results do not indicate any differences that might result from one or more of the video club groups specificity. This finding may be interpreted as a sign of procedural validity of the video clubs. In all of them the same trends prevailed: the consistence of the shifts towards more attention to the categories of aims and content in teachers' selective attention. In terms of the objectives of video clubs, i.e. promoting professional vision for communicative competence development in pupils, this fact may be perceived as positive evidence.

It may be concluded that the response to the second research question to a certain extent triangulated the results obtained in the first analysis, and, in addition to that, confirmed some characteristics of teachers’ selective attention development identified in research on teachers mathematics (e.g. van Es & Sherin, 2008), namely its individual character. In order to gain deeper insight into what teachers notice and how it may change in the video clubs, however, further analysis of the teachers’ pre- and post-interviews aimed at the content of their comments (including their complex or integrated character) would be desirable.

6 Discussion

The presented study is a part of larger research focussing on EFL teachers’ professional vision and its development. In this paper we focused on teachers’ selective attention and how it changes after their participation in video clubs. In the video clubs we set out to develop a specific aspect of EFL teachers’ professional vision, namely the attention to conscious development of pupils’ communicative competence. During the intervention we not only aimed at developing their professional vision as such by directing their attention when observing classroom videos, we also aimed at their professional knowledge that strongly influences what is noticed and how. Van Ek’s model of communicative competence was introduced as a part of the video club (declarative knowledge), and the participants were also provided with an opportunity to use it in collaborative lesson design, to implement it when teaching their own class, and to reflect on this experience.

Our study showed that participants’ selective attention changed after video clubs. They tended to comment more on aims, content, and context, and less on processes and the teacher. These tendencies were evident in both types of comments, even though there were minor differences in the comments on own and other video (especially in the category pupils).

In the context of our intervention aim, these results seem encouraging. Our programme was aimed at helping the participants focus on the development of pupils’ communicative competence as the overall aim of foreign language teaching. It is necessary to understand communicative competence as a general idea, the aim on the horizon. It might be perceived as distant (in terms of time) but is immediately relevant when planning instruction and delivering lessons as it guides the particular lesson and activity aims and content, and also the choice and structuring of processes (teaching methods, organization forms, etc.). The results thus suggest that the intervention was successful: the participants paid more attention to aims and content when commenting on classroom videos after video clubs.

There was also a decrease in the number of comments related to the teacher and their performance which is consistent with previous studies (e.g. Sherin & van Es, 2009). Should we only consider the data related to participants’ own videos, we might be able to explain this decrease by the novelty of the experience of seeing oneself on screen that wears off by the end of the programme. However, as the decrease is consistent across the other and own videos, we can conclude that there was indeed a significant shift in participants' attention away from the teacher towards content, aims, and context.

Our study was conducted in the context of EFL teachers' professional development. However, the findings correspond with previous research on developing teachers' professional vision in other domains (mainly mathematics education). It has been shown that pre-service and in-service professional development programmes have effect on teachers' professional vision, both in general (e.g. Star & Strickland, 2008) and also when the intervention is targeted at a specific aspect of professional vision. An example of the latter is video clubs of Sherin and van Es (2009) that aimed to help teachers focus on students' ideas and student thinking. When the content of the pre and post video clubs interviews were compared, there were significant differences in terms of how much the teachers addressed students and mathematical thinking in their comments. The occurrence of these two categories increased significantly whereas less attention was paid to the teacher and to the atmosphere.

It has also been established that courses focussing on developing teachers' knowledge have positive effects on participants' professional vision (Stürmer et al., 2013a). Our video clubs combined both approaches – focus on the development of both professional vision and professional knowledge. From the results of our study, it would appear that the concept of communicative competence has been to a certain degree incorporated into participants' knowledge structures. This might have been facilitated by the fact that not only information about the concept was provided, but that an element of lived experience and its collaborative reflection was also included in the intervention. However, in order to confirm such a conclusion, a deeper insight into the comments within the content and aim categories is necessary.

Another limitation of the present study was the low number of participants and convenient sampling. For obvious reasons, only teachers interested in the intervention programme participated. In future studies, including a control group might be desirable.

Nevertheless, our data afford further analyses. First, an exploration of how the different categories describing selective attention are combined in teachers' comments and how this changes after video clubs is needed. This could shed more light on the success (or lack of thereof) of video clubs. As mentioned above, communicative competence that stood in the foreground of our intervention efforts is a unifying concept that connects our reasoning about aims, content, processes, and pupils. It would thus be interesting to find out whether the teachers comments showed more integration in terms of categories combinations.

When investigating professional vision, it is not only "what" teachers notice that is important, but also "how" they reason about classroom situations. The interviews need to be further analysed in terms of knowledge-based reasoning in order to determine the overall changes in participants' professional vision.

Even though there are many more questions yet to be answered, this paper attempted to open the issue of EFL teachers' professional vision and its development through video clubs, which is a topic that has not received much research attention yet.

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Eva Minaříková,
Institute for Research in School Education, Faculty of Education, Masaryk University
Poříčí 31, 603 00 Brno, Czech Republic
minarikova@ped.muni.cz

Michaela Píšová
Institute for Research in School Education, Faculty of Education, Masaryk University
Poříčí 31, 603 00 Brno, Czech Republic
pisova@ped.muni.cz

Tomáš Janík
Institute for Research in School Education, Faculty of Education, Masaryk University
Poříčí 31, 603 00 Brno, Czech Republic
tjanik@ped.muni.cz

Klára Uličná
Institute for Research in School Education, Faculty of Education, Masaryk University
Poříčí 31, 603 00 Brno, Czech Republic
klara.ulicna@pedf.cuni.cz

Ability to Notice Mathematics Specific Phenomena: What Exactly Do Student Teachers Attend to?[1]

Naďa Vondrová, Jana Žalská

Charles University in Prague, Faculty of Education

Abstract: The aim of this paper is to a) shed light on the nature of student teachers' noticing of mathematics specific phenomena as observed in a video recorded lesson and to b) compare this nature for student teachers at the beginning of their master studies at the university and those at its end. Our study is based on a thorough examination of student teachers' written analyses (n = 169) of video recorded lessons. We capture the qualities of these in terms of the author-defined notion of mathematics specific (or MS) phenomena by a) matching the students' comments against what we view as important issues in the lessons, and b) developing a framework to further characterise the nature of the observations. Both qualitative and quantitative results corroborate the findings of earlier research on pre-service teachers' lesson analyses in that they pay limited attention to content in the lesson observed. Moreover, it transpires that students tend to notice MS phenomena which are not identified as important by experts and that the demonstrated ability to notice MS phenomena does not show significant differences for students in two distinct stages of a teacher preparation programme.

Keywords: ability to notice, pre-service mathematics teachers, mathematics education

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Observing classroom instruction is a substantial part of mathematics teacher preparation programmes (see, e.g., Star, Strickland, 2008). When observing lessons taught by others (live or on video), pre-service teachers are expected to, among other things, notice those aspects of the lessons that involve mathematical content and how pupils[2] make sense of the content with the help of the teacher. However, experience from our mathematics education course shows that students often do not respond to noticeable (from our point of view) events specifically pertinent to mathematics teaching and learning. Do the students take away from the video we give them to watch what we would hope for them to take away? Are there any content issues in mathematics lessons which are easier for them to notice than others? Do students in their more advanced stages of the programme really notice more of the important didactic features when observing a lesson? We started looking into this issue more systematically.

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[2] We will use the term students for pre-service teachers and the term pupils for children at primary and secondary schools.

1 Theoretical framework and related literature

Noticing is a rapidly growing strand of research (for a comprehensive review, see Sherin, Jacobs, & Philipp, 2011). Schoenfeld (2011) succinctly summarises why noticing is important: noticing is consequential (what you see and do not see shapes what you do and do not do); noticing is important because it can initiate changes in practices; teachers' noticing is intimately tied to their orientations (including beliefs) and resources (including knowledge); noticing is paramount for adaptive and responsive teaching in which teachers attend closely to pupils' ideas. Teacher noticing is characterised in different ways, most frequently as involving the processes of attending to particular events in an instructional setting and making sense of these events. For example, van Es and Sherin (2002, p. 573, as cited in Sherin & Star, 2011) propose three aspects of noticing:

> (a) identifying what is important or noteworthy about a classroom situation; (b) making connections between the specifics of classroom interactions and the broader principles of teaching and learning they represent; and (c) using what one knows about the context to reason about classroom events.

Some researchers concentrate on the first component of noticing, that is, what is attended to, others look into how it is interpreted, and still others add observers' intended response to what is being noticed to the noticing framework.[3] Noticing has been studied for different groups of participants and in different settings. We mostly build on studies which deal with (future) mathematics teachers within the context of analysing a mathematics lesson on video and in particular, studies investigating participants' attention to content-specific phenomena.

1.1 Attention to subject-related content

The focus of attention has been studied by different measures in studies on noticing. Researchers have investigated the distribution of participants' comments among different aspects of the lesson as well as their quality. For example, van Es and Sherin (2010) coded each comment for *Actor* (the object of focus), *Topic of focus* (this category included, among others, *Mathematical thinking*), *Stance*, *Specificity,* and *Evidence*. Stockero (2008) used categories of *Agent*, *Topic* (*Mathematical thinking* vs. *Pedagogical issues*), *Grounded in evidence or not*, and *Level* (describing, explaining, theorizing). *Mathematical content* was one of the codes in Kersting et al.'s (2010) study, alongside *Student thinking*, *Suggestions for improvement*, and *Depth of interpretation*.

[3] As Sherin (2007) suggests, noticing can be seen in connection to professional vision which has two components (a) noticing or selective attention and (b) knowledge-based reasoning. Janík et al. (2014) suggest that for pre-service teachers, the term pre-professional vision might be more appropriate.

The above codes refer to both the generic and content-specific pedagogical issues observable in the lesson, whose interplay is at the heart of the quality of the lesson taught. In this study, we will focus on the content-specific issues. Studies have shown that participants do not pay much attention to content issues when observing a video. For example, Carter et al. (1988) claim that inexperienced teachers have difficulty focusing on pupils' (rather than teachers') actions, tend to view a lesson merely as a chronological but disconnected sequence of events, and are not particularly observant about issues of content. Santagata, Zannoni and Stigler (2007) found out that for analyses of both the whole lesson and parts of lessons, students' comments "tended to be about general didactic choices and, when the mathematical content of the lesson was mentioned, only seldom were mathematical ideas used directly to discuss the teacher's actions" (p. 131).

As far as our search in relevant literature suggests, only Mitchell and Marin's (2015) and Kersting et al.'s (2010) studies specifically focus on content. Participants in the former used the *Mathematical Quality of Instruction* (MQI) framework (Hill et al., 2008) for coding a video of their own teaching and the teaching of others. The authors claim that by using MQI, they purposefully narrowed the participants' focus to "topics most salient to mathematics instruction: mathematics pedagogy and student work with mathematics, rather than classroom management or general pedagogy" (p. 558). The latter study used written video analyses to assess teachers' knowledge and to relate it to their mathematical knowledge for teaching (MKT). An overall correlation between the MKT test and the video analysis score was demonstrated, with the *Mathematical content* code as the strongest predictor, explaining 37% of the variance in MKT scores.

Attention to subject content and the way it is present in lessons is indeed an important aspect of teachers' noticing. For example, Star, Lynch and Perova (2011) identified what they call important questions (see below) in all observation categories, with the fewest from classroom environment and most from pedagogical choices made by the teacher, mathematical content addressed in the lesson and teacher-initiated communication. The authors propose that "it is *always* more important to observe mathematical content carefully than to observe classroom environment carefully" (p. 132). Similarly, Star and Strickland (2008) consider the ways the mathematical content of a lesson is explained and represented as important features worthy of noticing.

1.2 Important moments in a mathematics lesson

Most studies on noticing do not distinguish between important and less important events in a mathematics lesson. Star, Lynch and Perova (2011, p. 120) even write:

> To be clear, some classroom events are certainly more important than others, and it is critical that preservice teachers be able to attend to and interpret these important events. However, we believe that teachers do not have the ability to notice important

> events (or even to distinguish important from trivial lesson features) until after they have developed the ability to notice (even trivial) classroom features.

The aim of the course described in their study was to activate students' noticing skills of all kinds of events. However, the authors do say that the ultimate goal is for teachers to be able to notice important classroom events and they admit that neither their nor Star and Strickland's (2008) studies showed "whether it is better to focus first on improving teachers' awareness of the full range of (trivial and important) events (as was done here [in their course]) or to focus explicitly on only important events from the outset" (p. 132).

We consider important moments of a mathematics lesson those which are generally accepted to play the key role in pupils' learning of mathematics, that is, the types of tasks that teachers present and the kind of discourse that they orchestrate when implementing the tasks in lessons (Hiebert et al., 2003). Moreover, we put an emphasis on the active role of pupils in developing their knowledge. This means that we deem important the concept of *opportunity to learn*, defined as the "circumstances that allow students to engage in and spend time on academic tasks such as working on problems, exploring situations and gathering data, listening to explanations, reading texts, or conjecturing and justifying" (Kilpatrick, Swafford, & Findell, 2001, p. 333). It includes "considerations of students' entry knowledge, the nature and purpose of the tasks and activities, the likelihood of engagement, and so on" and is seen as the single most important predictor of pupils' achievement (Hiebert & Grouws, 2007, p. 379).

1.3 Our previous work

We build on the work mentioned above (and others) by selecting a particular focus for noticing, namely the mathematics specific context of the lesson. As the idea of noticing is based on specific, concrete, data observation, we will use the word phenomenon to refer to an observable situation. By *mathematics specific (MS) phenomena* we mean such that could be observed, explained, inferred or interpreted in relation to either mathematical or didactic issues pertaining to the teaching or learning of mathematics (as opposed to the teaching and learning of other subjects).[4] Thus, noticing MS phenomena can be seen as part of professional vision of a teacher of mathematics as opposed to a teacher of other subjects. When noticing MS phenomena and commenting on them, students demonstrate both content and pedagogical content knowledge (Shulman, 1986). The above research studies include noticing MS phenomena in one way or another but their categories do not match ours. For example, our MS phenomena category fully aligns with Star and Strickland's (2008) Mathematical content category but it aligns with their categories Communication and Task only insofar as the phenomenon in question involves some notion of teaching and learning mathematical content.

[4] Further clarification of this concept will be provided in sections below.

The presented study is a continuation of our previous study (Vondrová & Žalská, 2012), in which we were able to report the results of a detailed examination of 30 students' written analyses of a video recording of one full mathematics lesson. Overall, we confirmed that although the group of participants paid attention to issues of general pedagogy and classroom management, they did not tend to notice and comment on even prominent aspects related to mathematical content, such as a carefully devised series of tasks that the teacher in the video used to introduce new mathematical content, or the mathematics content contained in individual pupil-teacher interaction. The study also raised the question of explicitness – surely, the noticing or not of MS phenomena depends on their "explicitness" in the video.[5] The data also suggested that there may be some differences in noticing MS phenomena between students whose analyses were written in the early stages of their master study and those in later stages. To answer these questions, the present study expands the previous one by an increase of collected data (from 30 to 169 analyses).

1.4 Research questions

RQ1. What MS phenomena are noticed by students in a mathematics lesson on video? In particular, are there any types of MS phenomena that are commented on more frequently than others?

RQ2. Do students who are at the end of their master study notice MS phenomena differently from those at its beginning?

For our study, the conception of teacher noticing involves both noticing and sense-making of the above discussed van Es and Sherin's framework. In other words, students provide evidence of noticing by making a comment about the noticed event and it does not suffice that they simply describe an event in the lesson: there must also be some evidence of sense-making (such as interpretation or evaluation). Note that the nature of interpretation and evaluation or their quality are not subject of our study.

2 Methodology

Two methodological issues are particularly important to bear in mind. First, the research design is not a longitudinal study of the development of a particular group of students, in a teaching experiment. Rather, we compare two distinct groups of student teachers at different points of their masters degree programme. The second issue concerns research on noticing in general. There is no other way to capture the

[5] Studies on noticing generally do not refer to explicitness. The exception is (Blomberg, Stürmer, & Seidel, 2011) in which the authors rated clips according to "how difficult they were to evaluate, with some clips portraying aspects of teaching and learning more explicitly observable than other clips" (p. 1134).

ability to notice than through records of what students say or write. Thus, we can only believe their comments to be evidence of the ability to notice.

2.1 Participants and the teacher preparation programme

Table 1 presents an overview of the 4 semester masters programme for future mathematics teachers at lower and upper secondary schools. An important part of the programme is devoted to observations of classroom instruction. For example, future teachers spend one day a week in a particular school within a so-called clinical semester. They observe lessons and attend a seminar led by a specialist in pedagogy and a specialist in psychology where the different pedagogical and psychological standpoints of the observed lessons are discussed and reflected on. Besides, student teachers spend the total of 8 weeks at (at least) two schools during their teaching practice assignments, which consist of observing lessons taught by mentor teachers and teaching 4 weeks for each of the two subjects they specialise in. They discuss the observations and their teaching with their mentor teacher at the school, without university-sponsored feedback from a mathematics education specialist.[6]

Table 1 Overview of the mathematics teacher preparation programme

<table>
<tr><th>Mathematics education experience</th><th>Time allocated to the mathematics education course
Number of videos used</th><th>Other relevant courses</th></tr>
<tr><td>Semester 1: Mathematics education course 1</td><td>12 × 3 lessons
2 whole lesson videos
9 clips</td><td rowspan="6">General and school didactics course (12 × 3 lessons)
Pedagogical and school psychology course (12 × 4 lessons)
Clinical semester at a school (once a week, observations of lessons, reflective seminars with a specialist in pedagogy and a specialist in psychology)
Mathematics courses (geometry, mathematical analysis, abstract algebra)</td></tr>
<tr><td rowspan="2">Semester 2: Mathematics education course 2</td><td>8 × 4 lessons
2 whole lesson videos
2 clips</td></tr>
<tr><td>teaching practice (4 weeks at the primary school)</td></tr>
<tr><td rowspan="2">Semester 3: Mathematics education course 3</td><td>8 × 2 lessons
2 whole lesson videos</td></tr>
<tr><td>teaching practice (4 weeks at the secondary school)</td></tr>
<tr><td>Semester 4: Course on the work with talented pupils in mathematics</td><td>11 × 2 lessons</td></tr>
</table>

6 With the exception of two to four lessons.

The mathematics education courses are mainly focused on the development of students' pedagogical content knowledge:[7] the courses start with more general issues such as a theory of concept development process in mathematics, teaching based on the ideas of constructivism, communication patterns in mathematics lessons, etc. They are applied in the rest of the courses when the focus is on the mathematics of lower and upper secondary schools. The course material also includes several tasks with video recordings of mathematics lessons. Table 1 shows how many whole lessons/clips the students are asked to see and comment on in some way. Note that the development of noticing skills is not the main goal of the courses. Rather, the videos are used as a means of illustrating theoretical knowledge and linking theory and practice, a basis for discussion, providing students with more experience, and also making them aware of the complexities of teaching and learning processes.

The participants of the study (n = 169) were student teachers − future lower and upper secondary mathematics teachers in their two years of masters studies. We collected their answers at different stages of their programme. Students referred to as DM1 (n = 81) participated at the beginning of their first semester, and DM3 students (n = 53) in their third or last semesters of the study. Thus, the relevant difference between DM1 and DM3 students is a year of participation in the teacher education programme. The third group of students referred to as DM2 (n = 35) participated in the middle of their masters study. Only 10% of all the participants had some teaching experience as unqualified mathematics teachers at the time of writing the analyses. Most of the participants were in their early- or mid-twenties, the oldest participant was 34 years old. Prior to starting their two-year masters studies, they all had completed a bachelor degree in "mathematics with the focus on education" (mostly at the same university) or an equivalent degree.

2.2 The video recorded lessons

In a course for 5 doctoral students[8] in mathematics education in 2009, observations and analyses of 10 videotaped lessons from TIMSS 1999 Video Study were carried out. At the end of the course, the students were asked to choose lessons which a) they considered authentic,[9] that is, showing teaching practices to which they can relate and which are understandable for them, b) concerned subject matter with which student teachers are familiar, c) are self-contained (have a clear introduction and ending, so that the knowledge of the content of the previous lessons is not necessary),

[7] Naturally, the mathematics education courses were not taught in the same way in all the years in which we collected data (albeit the course teacher was the same). Their content has undergone changes in terms of compulsory reading, tasks assigned and the set of video recordings used. But the core of the courses remained the same.

[8] The students had a master degree in mathematics education and had some teaching experience from lower and/or upper secondary schools. They were in their second or third year of Ph.D. study in mathematics education in which they worked on their own research. They can be considered experts.

[9] It has been shown that perceived authenticity of the video material has an impact on reflections (Blomberg, Stürmer, & Seidel, 2011).

d) are reasonably rich in generic and subject-specific content (Blomberg, Stürmer, & Seidel, 2011) so as to ensure that they would offer a solid base[10] for our study (there is quite a number of events to be noticed), e) depict MS aspects of teaching in a clear way, that is, they are easily observable. From the five lessons selected by the doctoral students, we chose three which do not present any particular topic covered in depth by one mathematics education course or another as we did not want to use the lessons as a direct extension of the students' course session experience.

The selected lessons of Grade 8 classrooms were recorded[11] in classrooms in two countries (AU04 in Australia, HK01 and HK04 in Hong Kong). They were all conducted in the English language and given to the students offline,[12] with Czech subtitles. Lesson HK01 is 35 minutes long (40 pupils, the topic of square roots), HK04 32 minutes long (42 pupils, the topic of equations that are identities) and AU04 69 minutes long (30 pupils, the topic of ratios).

2.3 Data (video based task)

The participants were given an assignment to watch *one* of the three video recordings (individually, outside class, with the possibility to rewind or pause). They were asked to watch the video and write their reflection on it. They were to write what they "considered important and noteworthy". They were told that there "were no correct or wrong answers" and that they should "feel free to write their honest opinions". There are many aspects which might be attended to in the lesson and as we wanted to see whether the students would choose the MS one, we did not give them any more guidance as to what their reflection should include, nor were there any requirements about the depth and/or detail. There was no other information than the pupils' age and the country of origin regarding the lessons provided for the analysis.

The shortest analyses were as short as ten sentences, the longest ran two pages long. Table 2 gives a summary of the collected data in terms of the number of commented video recordings and the advancement in the teacher preparation programme of the students. The data were collected between 2009 and 2014.

Table 2 Summary of collected data (number of analyses for each group of students and video)

Videos/Course	AU04	HK01	HK04	Total
Total all students	**54**	**57**	**58**	**169**
Group DM1	16	33	32	81
Group DM3	24	13	16	53
Group DM2	14	11	10	35

[10] The Australian lesson has already been shown to serve our needs in our previous study (Vondrová & Žalská, 2012).

[11] See http://www.timssvideo.com/videos/mathematics/Australia and http://www.timssvideo.com/videos/mathematics/Hong%20Kong.

[12] That means that the students did not read the comments provided for the lessons by their teachers and researchers on the web.

2.4 Data analysis

The analysis of the students' responses was done by first selecting units of analysis that were MS related. Each unit contained a sentence, sometimes a few sentences (not necessarily consecutive in the written analysis structure) that commented on the same MS issue. Then a coding system was applied to these units of analysis. Recall that in order to be assigned a code, the comments had to have MS content and go beyond the cognitive level of description.

The coding system consisted of two subsystems described in the following sections: one coding for the expert-identified MS phenomena and one coding for more general MS categories.

Expert analyses in research on noticing

Using an expert analysis of a lesson as the guiding framework for data analysis is not unusual in research on teachers' noticing. For example, Star, Lynch and Perova (2011) created an expert analysis of videos whose results were important questions: "Questions that both raters independently scored as assessing important features of each lesson were classified as *important questions*. All other questions were classified as *other*." (p. 129) The expert analysis was used as a measure for assessing the participants' ability to notice. In the study of Blomberg, Stürmer and Seidel (2011), experts prepared items for rating all video clips together with an expert norm value system. Participants' responses were compared and assigned a value of either 1 (match with the expert norm) or 0 (no match with the expert norm). Star and Strickland's (2008) validation of measures (which they wanted to use to assess students' ability to notice) consisted of making a set of features of the lessons to be noticed and then comparing them against the video analysis made by six experienced mathematics teachers. Before using their expert analysis with their study participants, they eliminated items for which only two or fewer teachers provided a correct answer. Finally, Mitchell and Marin (2015) coded each lesson used in video club sessions by the MQI coding and calculated the percent alignment between participants' scores and the master rater scores.

Important phenomena (expert MS phenomena)

Of course, determining what is noteworthy in a lesson from the point of view of mathematics teaching depends on one's image of what is actually important in teaching. We considered noteworthy events in which the teacher introduced and developed pupils' understanding of a concept or algorithm, in which he/she reacted to pupils' questions and errors, or in which a pupil showed a sign of (mis)understanding the concept/algorithm, etc. (see section 1.2).

A coding system based on an expert analysis of the three lessons in question was developed. Two authors of the paper (a mathematics teacher educator and a doctoral student in mathematics education with ample experience with lesson analysis) and a doctoral student who had taken part in the course described above assessed the videos independently and then met to discuss and agree on the set of MS phenomena that were particular to each lesson. The agreement of three experts thus served as a validating tool.

The set of MS phenomena was selected based on their observability and relevance to the notion of noteworthy events shared by the coders. Interestingly, for each lesson there was the same number (7) of observable expert MS phenomena on which the experts agreed (see Table 3). The description of all of them is beyond the scope of this paper. One example is the code "Challenge?" which was used for students' comments that indicate that the teacher in lesson HK01 poses a problem that she presents as "challenging". However, she supplies three possible solutions for pupils to choose from, thus modifying the problem and reducing it to a cognitively lower task. An example of the unit of analysis assigned this code is: "I would not give pupils the solution choices, e.g., why did she write the choices for $\sqrt{(-4)}$ (= 2, = −2 or no solution) on the blackboard? It seems to me that pupils would have been able to find the solution without this help. At least they could have tried." Some other examples of expert MS phenomena are in section 3.

The students' written reflections were coded for all 7 expert MS phenomena pertaining to each lesson. As stated above, the unit of analysis were comments on the same issue – it could be one sentence or several sentences. If the student returned to the same issue several times in the written reflection, it was only coded once. The coding for the expert MS phenomena was binary (present or not) for each MS phenomenon, without evaluating the quality of the relevant comments. We did not distinguish whether the student's comment was interpretative or evaluative either.

Characterizing MS comments

After coding several written reflections for expert MS phenomena, we noticed that the students also commented on phenomena that were not part of the expert analysis but that were MS related. Thus, we coded the data in an inductive way, too – each time there was a comment which clearly was about a MS phenomenon, went beyond describing and was not included among expert phenomena, we assigned it a new code with a suitable name. We then organised the codes in the following system of categories:

Didactic Error: Content pedagogical (didactic) error (perceived as such by the student). The student is critical of the decision the teacher made. For example: "Finally the teacher repeats again that there can be two answers, i.e., there exist two [square] roots, but in my opinion, the teacher unnecessarily confuses things by using the minus sign." (HK01)

Didactic Alternative:[13] The student offers, whether as a complement to a criticism (Didactic Error) or not, an alternative action to be taken by the teacher. For example, "She should have left the [erroneous] record on the blackboard and use

[13] This category has a unique characteristic in that its phenomena are not observable in themselves, in other words, while a didactic error can be noticed, the alternative is, more accurately, provided or imagined. However, it has its place in our framework for noticing MS phenomena in that the comments that belong to this category are based on observed facts and their interpretation.

it to show what usually causes doubts, she should have explained better why she requires pupils to use the form $a^2 = 9$ again, the explanation could have even been made by writing the condition next to it, that is, that we solve the equation for $a < 0$." (HK01) We did not assign this code to comments semantically implying an alternative such as "She shouldn't have …", "It was confusing that …", etc. unless they include further elaboration.

Teacher's Mathematical Error: Mathematical error or imprecision of the teacher. The student criticises the teacher's conceptual, notational and computational errors or imprecise language. An example is: "However, he then says that for equations, pupils can have one or two solutions and the identities can have infinitely many solutions." (HK04)

Task Choice: Choice of a particular mathematical task or a sequence of tasks overall. For example: "The problems are logically sequenced, they are understandable and clear to pupils, and they gradually move into problems that are stated in a more general way." (HK01)

Task Analysis: Specific observation about or a deeper analysis of a task (apart from its selection by the teacher). For example: "When first introducing the pupils to the square root symbol, the teacher uses the same numbers as they used in the previous problem. I find that quite [effective]." (HK01)

Pupil Commentary: Commentary of a pupil's (or pupils') MS action. For example: "It's possible that the pupil who offered 2 as an answer […] probably understood that the equal division should be done on the 12 cubes, where there are more possibilities, but if the ratio is to be of two numbers, I can think of two equal piles." (AU04)

Teacher's Reaction: Teacher's response (reaction) to a particular pupil's MS answer/question, etc. For example, comments such as: "Mark stated an imprecise answer. The teacher transformed his sentence instead of explaining the error and letting him try to [restate the sentence] himself." (AU04)

Other: This category was used for miscellaneous MS comments, most of them referring to some theoretical knowledge from mathematics education. For example: "This step from a concrete example to a general concept requires a certain abstraction shift in pupils' minds." (AU04)

One unit of analysis could be coded for more than one category (typically, a didactic error was accompanied by a suggested alternative). As with coding for expert MS phenomena, we did not distinguish interpretative and evaluative comments and did not evaluate the depth of interpretation. While each expert MS phenomenon code could be used in the same written analysis at most once, the code for the general categories could appear in the same analysis several times (for example, the student commented on several didactic errors of the teacher).

Finally, all the identified expert MS phenomena were assigned one[14] of the general categories (for example, the above described expert-identified MS phenomenon

[14] Two in case of one expert-identified phenomenon for AU04 coded "M & Ms" in which at the end of the lesson, the teacher introduced a task which was not connected to the rest of the lesson in any obvious way; it belongs into two general categories, Task Choice and Didactic Error.

 coded as “Challenge?” was assigned category Didactic Error). Thus, units of analysis had zero codes (they did not include MS aspect), one code (they included MS aspect but were not among expert phenomena), two codes (they included MS aspect and were among expert phenomena) or three codes (see footnote 14).

To ensure both reliability and validity, a coding manual was gradually developed by the two authors, with detailed descriptors of the codes. The coders coded independently, checked their code assignments for consistency and then repeatedly met and discussed discrepancies until a 100% agreement was reached.

When looking for the answer to RQ1, all 169 students’ analyses were taken into account. The comparison framed in RQ2 is pertinent to the difference between DM1 and DM3 groups only.

3 Results

RQ1. Noticing MS phenomena in general and the nature of this noticing

To give the reader an idea of how frequently students mentioned MS phenomena in general, we looked at the frequencies of comments about MS phenomena in all written analyses (M = 5.79; SD = 4.51). Figure 1 shows that there were 10 analyses (5.9%) that had no comment pertaining specifically to the teaching and learning of mathematics,[15] the median value was 5 comments. The maximum number of comments was 26 (given by one student).

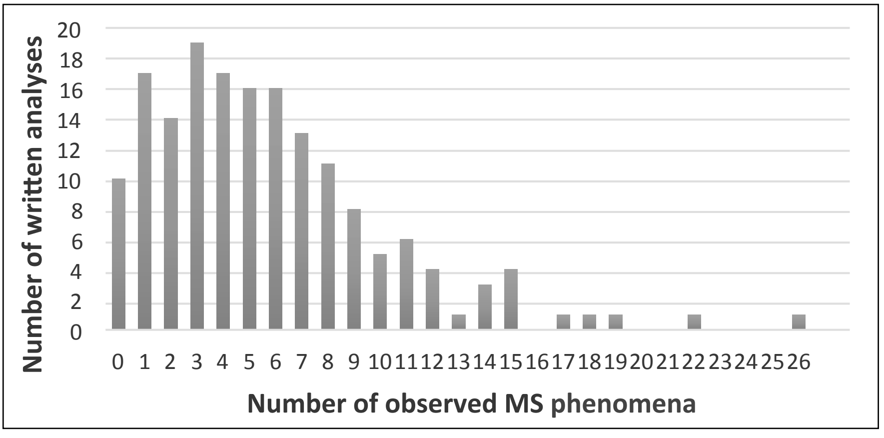

Figure 1 Frequency of observed MS phenomena in all written analyses (n = 169)

[15] That is, these analyses were general or focused on pedagogical and management matters.

Next, we looked at the type of phenomena the students' attention was drawn to. How much did the students notice the expert identified phenomena overall? Figure 2 shows the number of written analyses with various frequencies. Bearing in mind that each video contained 7 observable, expert-identified MS phenomena, the frequencies (M = 2.08; SD = 1.59) are fairly low, with the median value of just 2 (in fact, over two thirds of the students commented on two or fewer expert MS phenomena). Unsurprisingly, the ratio of students' observed expert phenomena to the expert phenomena in each lesson was fairly low (M = 0.30; SD = 0.23) (see also Figure 6).

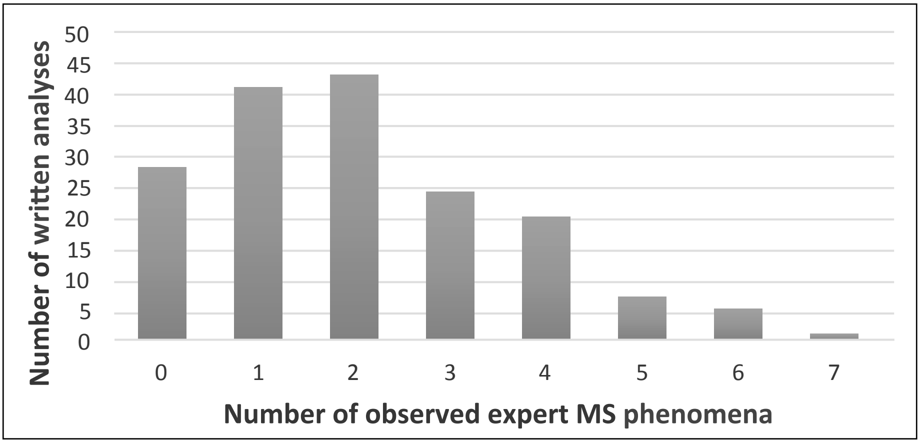

Figure 2 Frequency of observed expert MS phenomena in all written analyses (n = 169)

To look further into the nature of mentioned expert MS phenomena, we will compare the frequency of comments on all 21 expert MS phenomena. Table 3 depicts the ranks of the expert MS phenomena in connection to the lesson which they concern and to the general category which they belong to. We can see that the expert MS phenomena were mostly commented on in the lesson AU04, where all of them were noticed by no less than a third of the students. We can interpret this in various ways. This lesson has the least resemblance with a traditional Czech classroom and the activities and didactic tools[16] truly stand out, as well as the didactically problematic ending of the lesson (rank 9 in Table 3) with an activity that seems to be conceptually disconnected from the lesson[17] (the above "M & Ms" code). The length of the lesson may have also influenced the quality of the reflections, if for no other reason than that some of the phenomena simply took place over a longer period of time and therefore were easier to notice.

On the other hand, the phenomena ranking 18 to 20 concern the cognitive level of the teacher's questions which was quite low in both of the lessons, including the

[16] For example, the comments about the use of manipulatives in the lesson – rank 1 in Table 3, and about the incorporation of a pupil problem posing activity in the lesson – rank 2.

[17] Something that is not customary in a 45 minute traditional lesson in the Czech Republic.

 appearance of funnelling (Wood, 1998). The least noticed phenomenon (rank 21) regarded a teacher's repeated imprecise use of the 'infinitely many' for the number of solutions of a linear equation which is an identity in HK04.

Table 3 Frequencies of comments about *expert* MS phenomena and their ranks

Rank	Lesson	% observed	Category	Rank	Lesson	% observed	Category
1	AU04	72.2	Other	11	HK04	31.0	Task Choice
2	AU04	50.0	Task Choice	12	HK04	29.3	Other
3	HK04	46.6	Pupil Commentary	13	HK01	28.1	Pupil Commentary
4	AU04	42.6	Other	14	HK01	26.3	Didactic Error
5	HK01	38.6	Task Choice	15	HK04	20.7	Task Choice
6	AU04	37.0	Pupil Commentary	16	HK01	17.5	Teacher's Reaction
7	AU04	37.0	Other	17	HK01	17.5	Didactic Error
8	HK01	36.8	Other	18	HK04	12.1	Didactic Error
9	AU04	33.3	Didactic Error, Task Choice	19	HK01	8.8	Didactic Error
10	AU04	33.3	Task Choice	20	HK04	8.6	Didactic Error
				21	HK04	3.4	Teacher's Error

Finally, we characterized the nature of the comments in relation to the general categories. We found the average number of comments per student and category. Naturally, the videos contained different opportunities for comments pertaining to one category or another. We standardized the number of expert codes by the number of students to give a sense of comparison. Figure 3 shows how much more (or less) students commented on phenomena belonging to one kind of category. For example, the figure shows that students commented less on pupils' thinking (category Pupil Commentary; 0.21) than the experts, across the videos. The students tended more to comment on a teacher's didactic error (Didactic Error; 2.29) than on phenomena from all the other categories, and the least commented on category was Teacher's Mathematical Error (0.16)[18]. Students significantly lagged behind the expert analyses in commenting on task choice (Task Choice; 1.02).

Of course, the standardization is really only giving a very rough guideline because there were other opportunities, apart from the expert phenomena, that the students found noteworthy. We confirmed (as already suggested by the low frequency of observed expert phenomena) that the students' and the expert comments in one category were more often than not concerning *different phenomena*. In fact, on

[18] Only 22 students (13%) commented on one or more mathematical errors of the teacher.

average, 56% of the students' MS related comments were about phenomena other than those identified in the expert analyses. The box-and-whiskers graph on the right in Figure 7 depicts the distribution of the ratio of observed *non-expert* MS phenomena to all observed MS phenomena (M = 0.58; SD = 0.30) for all students.

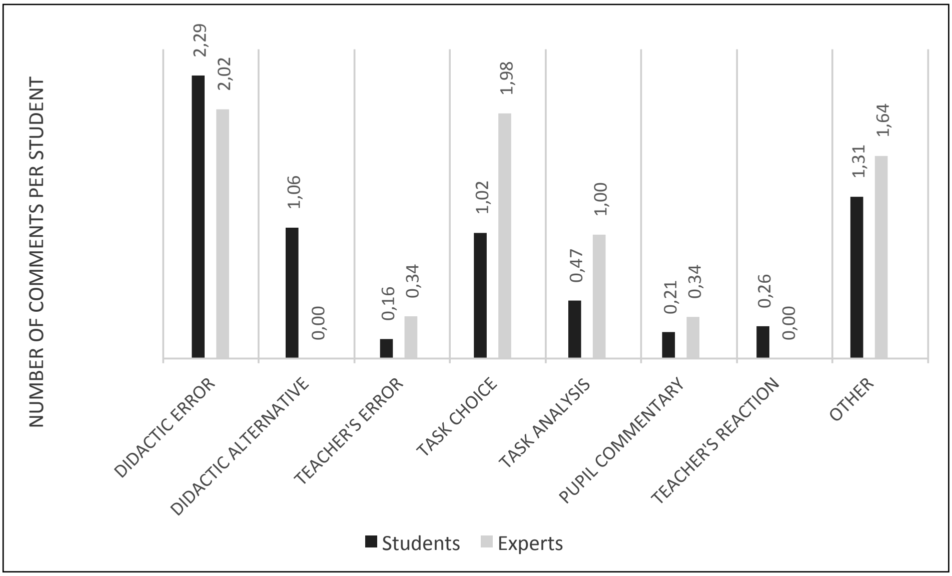

Figure 3 Frequency of comments in categories: students and experts[19]

The general category of Didactic Error ranked among the lowest in Table 3 (that is, the students commented the least on *expert* MS phenomena that were coded as didactic errors). Yet, Figure 3 shows that the category was the most popular, even exceeding the expert frequencies (unlike all the other categories). Apparently, the students were commenting on didactic errors that were not seen as important by experts (or were not seen as errors at all), and tended to not notice or to pass without commentary a teacher's decisions that were pointed out as lost teaching and learning opportunities by the expert analyses.

RQ2. Differences in noticing between the DM1 and DM3 groups

To identify whether there may be any differences between students at the beginning and end of their masters studies, we compared data for groups DM1 and DM3. It is important to keep in mind that we do not follow the development of one group of students. Technically speaking, our data allow us to compare two populations, each consisting of students with the same characteristic: the number of semesters they had attended the masters programme.

[19] The expert analysis did not, by nature, include any didactic alternatives.

We first looked at the presence of all MS comments in the students' written analyses. To find out whether there is a significant difference between groups DM1 and DM3, a Wilcoxon rank sum test was performed on the total of MS related comments written by a student. The test indicates that there is a difference ($\alpha = .05$) between groups DM1 and DM3 ($U = 1585.5$; $p = .010$; $r = .22$), however, the effect size is small. Figure 4 highlights the distribution of MS comment count per student for the group DM1 ($M = 5.3$; $SD = 4.42$) and the group DM3 ($M = 7.00$; $SD = 4.48$).

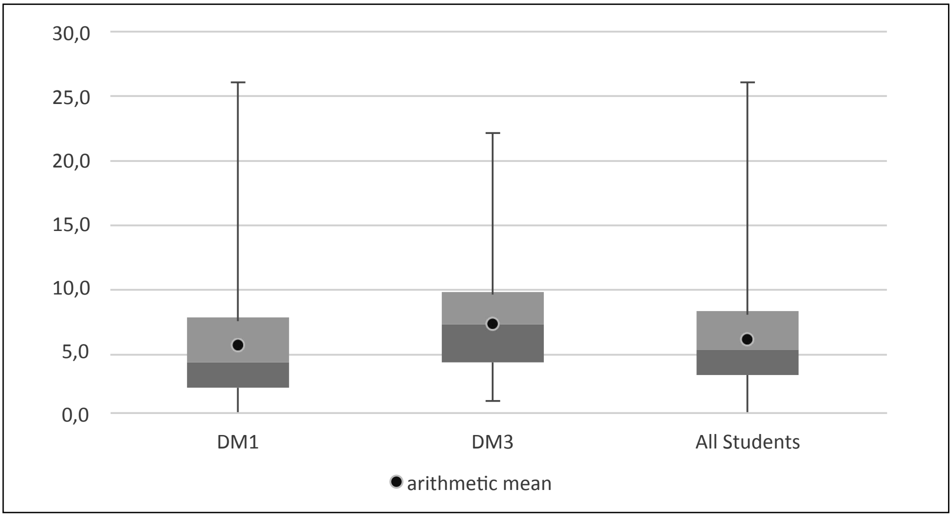

Figure 4 Distribution of MS comment count per student

Next, to partially avoid the influence of the particular video content[20], we standardized the frequencies per general category by the maximum value for each category and video. Table 4 shows the maximum values for each lesson and category. For example, number 4 in the "Task Choice/AU04" cell means that no student mentioned a phenomenon related to task choice more than in four instances (and at least one student did so in exactly four cases) when commenting on lesson AU04. In principle, we can presume that there were four opportunities on which a student could comment on Task Choice category in AU04. Surely, such a number of opportunities cannot be objectively arrived at, however, this provides a plausible kind of measure. The ratio of the student's actual number of observations made about that particular category and the maximum value tells us about his/her ability to notice the particular category.

[20] The number of MS related comments of a student for a particular video recorded lesson was calculated to show whether any video stimulated a significantly higher (or lower) response in terms of MS comments from students. The values are fairly stable across the lessons: AU04 ($M = 7.48$; $SD = 5.60$), HK01 ($M = 6.68$; $SD = 5.16$), HK04 ($M = 6.21$; $SD = 5.84$). Still, we found it prudent to proceed with standardization as described in the text following this footnote, especially given the decisively longer run of lesson AU04.

Table 4 Maximum numbers of comments on each general category and each lesson

Maximum value	Didactic Error	Didactic Alternative	Teacher's Mathematical Error	Task Choice	Task Analysis	Pupil Commentary	Teacher's Reaction	Other
AU04	12	6	4	4	3	1	3	5
HK01	9	7	1	3	1	2	3	5
HK04	11	9	2	2	1	3	2	6

Figure 5 shows the differences between categories. In particular, it shows the mean standardized value for each category and group. We can see a noticeable difference in performance of the DM3 group: especially the Pupil Commentary and Other categories stand out. A substantial difference can also be seen for Teacher's Reaction and Task Analysis. The mean value for the count-to-maximum-count ratio for Pupil Commentary is 0.06 for DM1 and 0.23 for DM3. For category Other, the difference is caused by non-expert MS comments (i.e., not the ones included in the expert analysis), the mean value for which was 0.15 for the DM1 and 0.36 for the DM3 group. The nature of these comments is mostly related to instances of using theoretical didactic concepts related to the theory of concept development process in mathematics, something the students repeatedly encountered in their mathematics education

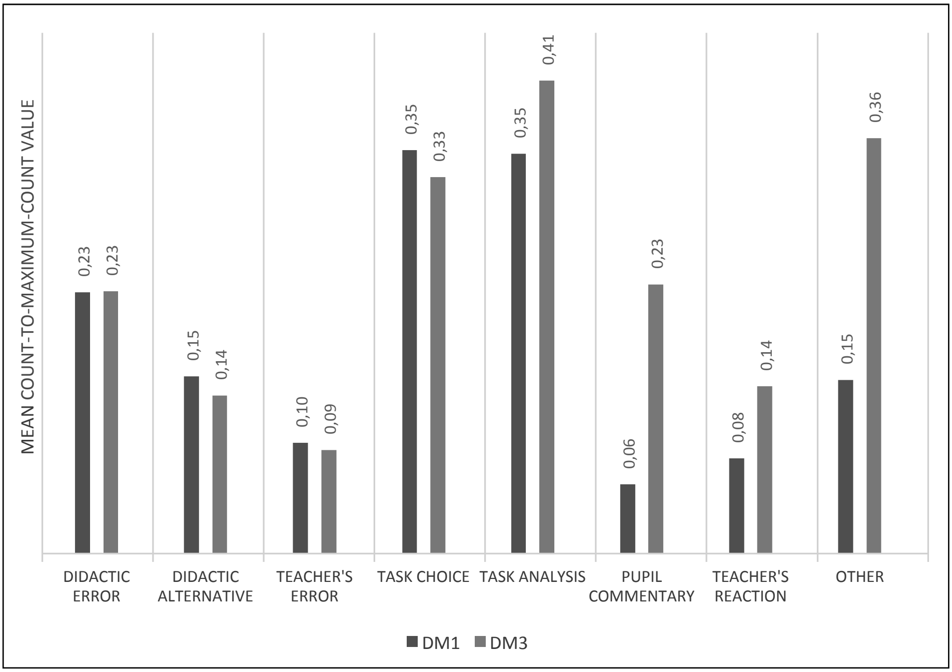

Figure 5 Noticing general MS categories for DM1 and DM3 groups

courses. Note that for category Didactic Error the mean value is about the same (due to rounding) and that DM1 performed slightly higher than DM3 in the number of comments from Didactic Alternative, Teacher's Mathematical Error and Task Choice.

Next, we wanted to look at how much the students commented on phenomena that were deemed important by the expert video analysis.[21] First, we wanted to see whether there was any difference in terms of students' noticing the expert phenomena. The box-and-whiskers graph in Figure 6 shows how the ratio of the observed expert phenomena to the expert analysis phenomena differed for the two groups. Again, a Wilcoxon rank sum test was performed on the ratios of groups DM1 and DM3 to test for a significant difference of the sample populations. The test shows a difference at ($\alpha = .05$) between the two groups and, again, the effect size remains small ($U = 1708.5$; $p = .042$; $r = .17$).

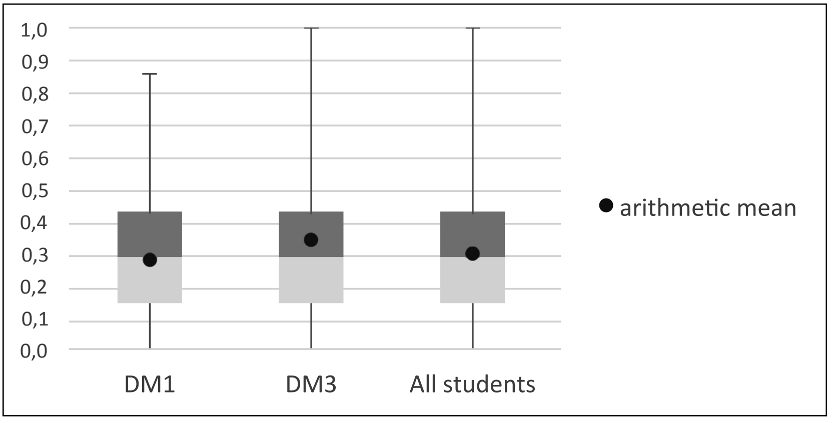

Figure 6 Commenting on *expert* MS phenomena: the distribution of the ratio "commented on *expert* MS phenomena to *expert* MS phenomena" for each group

Next, we computed the ratio "commented on *non-expert* MS phenomena to total MS phenomena" per student which shows us how often they commented on other than the expert identified MS phenomena. The high values in Figure 7 indicate that the students found many other MS phenomena worth reporting on in their written analyses. The proportion of comments that were related to other than the expert identified observable phenomena is high ($M_{DM1} = 0.58$; $SD_{DM1} = 0.30$; $M_{DM3} = 0.59$; $SD_{DM3} = 0.25$).

[21] The importance we give to this match is based on the fact that one of the experts was the sole teacher of the mathematics education courses described above in which she emphasised the aspects of teaching deemed important for the success of teaching mathematics.

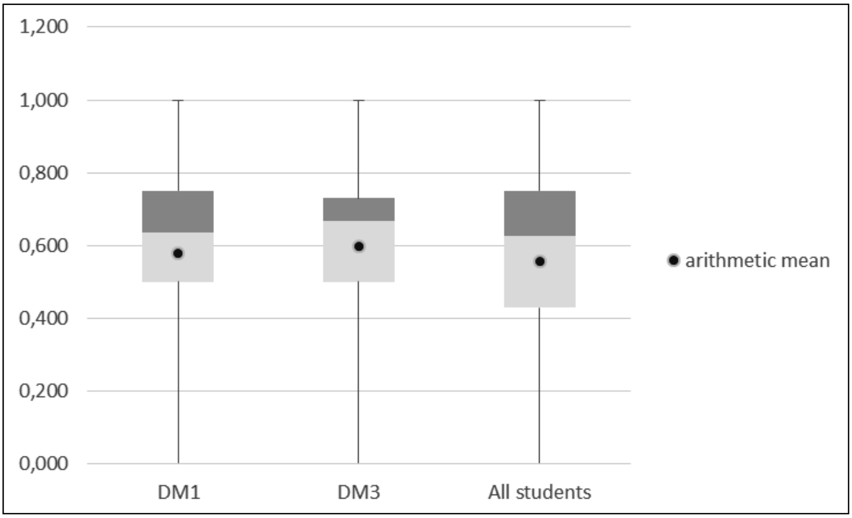

Figure 7 Commenting on *non-expert* MS phenomena: the distribution of the ratio "commented on *non-expert* MS phenomena to total MS phenomena" per student

Table 5 depicts percentage of students from the DM1 and DM3 groups commenting on *expert* MS phenomena. The lightly shaded boxes indicate where DM1 students outperformed DM3 students, the dark boxes mark the opposite situation. Although our data are not extensive enough[22] to give a clear picture, we noticed that the students from DM1 outperformed the DM3 students on the AU04 video by noticing the expert phenomena at a higher rate; while the expert phenomena contained in the other two videos was noticed more often by the students towards the end of their studies. This is an interesting phenomenon but would require further consideration. One interpretation could be that those features of the lesson which appear significant to less experienced DM1 students are deemed as commonplace, or not worth a commentary, by students with more experience in MS analysis and other academic background.

Again, we can see that DM3 students commented more on the expert MS phenomena involving categories Task Choice and Pupil Commentary. As for the earlier mentioned category Didactic Error, the DM3 students were far more likely to describe critically (53.8% over 15.2%, rank 14) a moment when a teacher introduces a problem as "challenging" but then decides to give her pupils multiple alternatives to choose from, lowering the cognitive task significantly. On the other hand, none of the DM3 students commented on another issue observable in the lesson (rank 17): the fact that the teacher uses exemplary problems and pupils simply follow the same procedure in the following practice activities (while over 30% of DM1 students commented critically on this feature).

[22] From 10 to 22 reflections per group per video, see Table 2.

Table 5 Percentage of students commenting on *expert* MS phenomena in DM1 and DM3 groups

Rank1	Lesson	DM1	DM3	Category	**Rank**	**Lesson**	**DM1**	**DM3**	**Category**
1	AU04	81.3	66.7	Other	11	HK04	34.4	25.0	Task Choice
2	AU04	56.3	41.7	Task Choice	12	HK04	21.9	**50.0**	Other
3	HK04	34.4	**68.8**	Pupil Commentary	13	HK01	33.3	**38.5**	Pupil Commentary
4	AU04	50.0	41.7	Other	14	HK01	15.2	**53.8**	Didactic Error
5	HK01	39.4	30.8	Task Choice	15	HK04	15.6	**31.3**	Task Choice
6	AU04	37.5	29.2	Pupil Commentary	16	HK01	6.1	**53.8**	Teacher's Reaction
7	AU04	56.3	33.3	Other	17	HK01	30.3	00.0	Didactic Error
8	HK01	36.4	**38.5**	Other	18	HK04	12.5	12.5	Didactic Error
9	AU04	50.0	16.7	Didactic Error, Task Choice	19	HK01	12.1	7.7	Didactic Error
10	AU04	37.5	**45.8**	Task Choice	20	HK04	03.1	**12.5**	Didactic Error
					21	HK04	06.3	00.0	Teacher's Error

Overall, our data show some tentative differences between the groups in both the number of phenomena noted, and in commenting on the expert-identified features of the lessons, with DM3 students showing slightly better abilities in both aspects (see Figures 4 and 6). The data showed a very large spread, and its distribution is characterised by the lack of normality. While one student commented on all expert phenomena and supplied more MS phenomena related comments than anyone else, there was a total of 10 students who did not report on any MS related phenomena at the required sense-making cognitive level.

The DM3 group seem to pay more attention to individual pupils' mathematical activities and the teacher's reaction to them. However, such comments remain relatively infrequent: for example, based on all the students' comments, there were 3, 3 and 2 opportunities to mention a teacher's reaction (Table 4), in each video respectively, and the average number of comments in this category was 0.26 (see Figure 3).

Not surprisingly, comments regarding Didactic Error were the most popular ones to be written down. In fact, there was almost no difference between the two compared groups. The quality of these criticisms, though, would require further investigation, as we were able to confirm that most of the time the students tend to comment on errors that fall outside the expert analysis.

4 Discussion

The goal of our study was to investigate to what extent students notice MS phenomena in a video recorded mathematics lesson, whether they pay particular attention to any type of them and whether there is any difference between groups of students at the beginning and end of their masters studies. At the outset, we limited our conception of the ability to notice to consisting of both identifying and sense-making (see Research questions, section 1.4). We can conclude that the participants in our study *noticed MS phenomena* with great variability. Over 50% of them noticed mathematics in learning and teaching in five or fewer instances in one video recorded lesson (the number is higher for a longer lesson but not proportionally). When it comes to noticing MS phenomena deemed important by experts, this number is significantly lower (median is 2, expert value is 7). For results of related research see below (Star, Lynch, & Perova, 2011).

The character of observers' comments depends on the choice of the lesson to be observed. For example, Kersting et al. (2010) point out the effect of selecting clips which call (or do not call) for suggestions for improvement. They conclude that clips with obvious shortcomings may prompt most teachers to make suggestions and thus it is impossible to discriminate among participants in terms of their ability to notice. When looking at our data through these lenses, we can see that the lack of evidence of noticing *important MS phenomena* in our study is especially true for lessons HK01 and HK04 that are similar to the traditional Czech classroom in the structure of a lesson, type of tasks and pupil-teacher interaction. This may indicate that the students' experience (as pupils) of traditional classrooms is strongly present in their professional vision, and reflected in their ability to notice phenomena that are important through the lenses of our conception of best practices (which is also the foundation of the teacher preparation programme). This, in turn, could partly explain the fact that students with more teacher preparation programme experience tended to score higher on noticing the expert phenomena in those two lessons – hypothetically, demonstrating a more critical eye for the analysis of the traditional practices.

It did not come as a surprise that phenomena regarding *didactic error* were the most frequent ones to be written down by our students. In our previous work (Vondrová & Žalská, 2012) we found that 28% of the students' comments were of a critical nature (pointing out both didactic and mathematical errors). The percentage was even higher for the bigger sample in this study (34% for didactic errors and 2% for a teacher's mathematical insufficiencies). Kersting et al. (2010) propose that suggestions for instructional improvement might be a sign of expertise. In their study, they found that "students of teachers who included suggestions for instructional improvement that they connected to mathematical content showed greater learning gains than did students of teachers who included either general pedagogical suggestions or no suggestions at all" (p. 178). Still, the quality of our students' criticisms should be further investigated. Our study showed that the students tended to comment on errors that fall outside the expert analysis. Notably, the lack of students' comments concerning issues connected to the teacher's choice of questions and tasks with a low cognitive level seems to align with the lack of critical skills towards the familiar, as hypothesized in the previous paragraph.

Our participants' ability to notice *the task* as a part of a lesson structure lagged the most behind the expert analysis. The choice of tasks is one of the key features of a successful mathematics lesson (Hiebert et al., 2003). It appears that students' attention should be drawn to this aspect in a more explicit way.

The least noticed category was related to *a teacher's mathematical errors and imprecisions*. This again confirms our previous results (Vondrová & Žalská, 2012). Although there were opportunities for noticing a teacher's mathematical errors or misrepresentations in all three videos, only a very small proportion of students (13%) noticed at least one of these and only two of the 58 students watching the video commented on a moment where the teacher's incorrectness was an important feature of the lesson, possibly hindering pupils' understanding of the content taught. Our data give us no further information regarding this particular feature of the pre-service teacher's (lack of) ability to notice. It is definitely one worth exploring.[23]

Finally, we looked into *the differences in the students' ability to notice MS aspect of a lesson* at the beginning and towards the end of master studies. Even though we found a difference in the ability between DM1 and DM3 groups, it was rather weak. Students leaving the programme noticed MS phenomena only slightly more often than those entering it. Similarly, in terms of the differences in noticing *important moments* in a lesson, we did not find any particular difference between DM1 and DM3 groups. Our study was not of the pre-test post-test design, however, we can see tentative corroboration of our results in studies of that design. Even studies which did investigate the development of noticing after a course specifically aimed at the development of noticing mostly report that the gain in the attention to important lesson features was rather weak. For example, in the pre-test of Star, Strickland and Perova's research (2011), the participants showed the same ability to notice important lesson features as other features. By the end of the course, their observation skills continued to be stronger on less important classroom features and they struggled to notice important classroom events. The authors offer two explanations. First, important events may be inherently harder to notice; the most "attention-grabbing features of a lesson (to a novice) may not be those that (in the eyes of an experienced teacher) are most important" (p. 131–132). Second, students may not have developed the ability to distinguish between important and unimportant lesson features. Both explanations are possible and could account for the fact that our students commented to a great extent on MS phenomena other than the expert ones.

[23] Mitchell and Marin (2015) focused students' attention to teacher mathematical error or imprecision (conceptual, notation, and computational errors and language imprecisions) within MQI framework. However, they only report their findings in general for all parts of MQI so we cannot compare their results with ours.

An implication of our study is that if we want to develop our students' ability to notice MS issues in a mathematics lesson, we have to specifically draw their attention to it by suitable tasks. This assumption is confirmed by Mitchell and Marin's (2015) study. They found out that the course specifically aimed at the development of MS aspects of the lesson indeed had a significant influence on students' ability to notice the more salient features of teaching mathematics (mathematical thinking included). Students also improved in their coding MQI accuracy, meaning that they became better at understanding what each code meant and were better able to notice instances in the lesson when there was a need for this code. Among others, the participants were asked in a pre- and post-interviews in an open way "what did you notice?" (this resembles the task we gave our students). By the end of the course, the number of instances of students' unsolicited noticing of MQI codes had doubled, that is, the students spontaneously mentioned MS part of the lesson in twice as many cases.

5 Limitations and further work

Our study has some limitations. As stated above, a one-to-one relationship between a noticed phenomenon and one that is chosen for a comment is difficult to establish; we could only work with its conjectured existence. Chances are that a student notices something but for some reason does not record it. Another issue concerns the interpretation of written comments. Some could have been written with a mathematics focus in mind, yet, because they were vague, we did not interpret them as such and did not assign them the MS code. In fact, we "are saying only what their comments are *about*, from a researcher's point of view, not what they were perceiving" (Sherin & Star, 2011, p. 76). Next, we assume that the students did their best to do the analysis. However, the context of the task assignment might not have aroused their motivation. We can hypothesise that if it were set as part of their assessment, they could have put more energy into writing deeper analyses. Furthermore, by focusing only on MS comments, we may have painted a rather distorted picture of the students' analyses. The students' analyses included comments on other aspects, general pedagogical ones, psychological, of management etc., which will be dealt with in a different paper (in progress). Finally, "determining what is and is not important is likely to be complex, nuanced, and fundamentally influenced by the perspective of the observer" (Star, Lynch, & Perova, 2011, p. 132) and thus, we should take into account that our expert analysis might be biased by our professional beliefs and experience.

As stated above, the study is not of a pre-test post-test design and we could only compare two different groups of students at the beginning and end of their university preparation without being able to gauge them as developmental changes. This is addressed in our subsequent research. In autumn 2014, we included a video course within the first mathematics education course and we will look into its effect on the development of students' ability to notice (not only) MS phenomena.

Another direction of our work goes towards using the coding framework of van Es and Sherin (2010) to capture noticing more generally (and to get more detail about the interpretative nature of students' comments) in order to be able to compare our results with those in the literature using the same framework. This would help us to complement the present study which distorted the image of students' ability to notice by focusing on the subject-specific content only.

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Naďa Vondrová
Department of Mathematics and Mathematical Education, Faculty of Education, Charles University in Prague
M. D. Rettigové 4, 116 39 Prague, Czech Republic
nada.vondrova@pedf.cuni.cz

Jana Žalská
Department of Mathematics and Mathematical Education, Faculty of Education, Charles University in Prague
M. D. Rettigové 4, 116 39 Prague, Czech Republic
zalska@hotmail.com

Changes in Pre-Service Teachers' Beliefs about Mathematics Teaching and Learning during Teacher Preparation and Effects of Video-Enhanced Analysis of Practice

Sonja Mohr
Technical University of Berlin, Humanities, Institute of Education

Rossella Santagata
University of California, School of Education

Abstract: While the construct belief is defined in various ways in teacher education research, most scholars agree that beliefs guide teachers' decision making and classroom behaviors and thus are an important aspect of teacher competence. Pre-service teachers (PSTs) have been typically found to hold a transmission view of mathematics teaching. The influence of teacher preparation on future teachers' beliefs about mathematics teaching and learning is unclear. This study investigates beliefs in a sample of U.S. elementary PSTs prior to teacher preparation and examines the impact on belief changes of two different mathematics methods courses. Findings reveal that while PSTs hold a transmission view of mathematics teaching prior to teacher preparation, their beliefs change during the program. In addition, PSTs who attended a video-enhanced mathematics methods course structured around systematic and collaborative analysis of practice showed stronger evidence of alignment with the beliefs that children can solve problems in novel ways before being taught how to solve such problems and that teachers should allow children to do as much of the thinking as possible during instruction, than a group of PSTs who attended a more typical version of the course. Implications for teacher preparation and future research are discussed.

Keywords: pre-service teachers, beliefs, mathematics teaching, video

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This paper summarizes the findings of a study that examined pre-service elementary teachers' (PSTs) beliefs about mathematics teaching and learning prior to and at the end of teacher preparation. Building on recent research on teacher beliefs, the present study investigates two approaches to teacher preparation and their impact on belief change.

Beliefs in the context of research on teacher learning have been described as a "messy construct" (Pajares, 1992, p. 307) because of the variety of meanings different scholars attribute to the term. Despite disagreements on the definition of

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 the term belief, most agree that teacher beliefs are acquired during past schooling and are thus outlasting propositions which can be consciously or unconsciously held. Beliefs are evaluative and subjective in nature and function as a guide to teachers' thought and behavior (Blömeke, 2012; de Fries, 2013; Pajares, 1992). Richardson (1996, p. 103) defined beliefs as "understandings, premises, or propositions about the world that are felt to be true." Their subjective character makes them distinguishable from teacher knowledge. Nevertheless, their guiding function makes them not less important in terms of teachers' decision making and teaching behavior (Schoenfeld, 2011). This point is also stressed by Ambrose et al. (2004) who have developed an innovative measure of teacher beliefs about mathematics teaching and learning that we used in the study summarized here. These authors argue that teacher beliefs possess four characteristics: 1) they influence perception; 2) they are dispositions to actions; 3) they are held with differing intensities; and 4) they tend to be context-specific. In our research on teacher learning we embrace this view of beliefs and we examine whether and under which conditions teacher beliefs are changeable.

1 State of research on pre-service teachers' beliefs and belief changes during teacher preparation

According to a review of research on PSTs' beliefs (Handal, 2003), PSTs hold a traditional set of beliefs at the beginning of teacher preparation. Their beliefs rely on their experiences in school and are not theory and knowledge-oriented. Accordingly, they often overvalue "the role of memorization of rules and procedures in the learning and teaching of school mathematics" (Handal, 2003, p. 50).

Although beliefs are often seen as stable and unchangeable, teacher preparation programs (at least those informed by research on mathematics teaching and learning) mostly attempt to shift PSTs' beliefs from traditional to progressive, that is towards a dynamic view of mathematics that values the process of inquiry and a constructivist point of view (Handal, 2003; Op't Eynde, de Corte, & Verschaffel, 2002).

Several longitudinal studies have been conducted to assess effects of teacher preparation and belief change of PSTs during teacher education. The results are inconsistent: some studies do not report any changes and intervention effects (Benbow, 1995; Foss & Kleinsasser, 1996), whereas more recent studies show that PSTs develop a more constructivist point of view during teacher preparation. For example, Biedermann, Brühwiler and Steinmann (2012) found that experienced PSTs saw mathematics as a process of inquiry rather than a set of rules and procedures, and they preferred active learning processes rather than teacher centered instruction to a greater extent than PSTs at the beginning of teacher preparation.

Different opportunities to learn are seen as important to foster belief change. Positive intervention effects have been detected when videos have been used to foster belief change or when field placements have been carefully designed and effective mentors provided (Blömeke et al., 2008; Philipp et al., 2007; Swars et al., 2012).

Video is used extensively in teacher preparation and professional development to situate teacher learning in the context of classroom practice (Borko et al., 2008). Video can serve as a common referent to ground future teachers' discussions of classroom teaching (Santagata & Guarino, 2011). New technologies allow for easy review of digital footage; the same excerpts can be watched several times to unpack important teaching-learning moments and detail features of teaching moves that might be unfamiliar to observers. An advantage of video over fieldwork observations is that teacher educators can control what PSTs are exposed to and guide their viewing and discussions to highlight particular features of teaching practices (Santagata, Zannoni, & Stigler, 2007). The examination of PSTs' beliefs about teaching and learning and how these might change as a result of using video strategically in teacher preparation is an under-studied area of research (Wang & Hartley, 2003).

One of the few studies on this topic was conducted by Philipp et al. (2007). These authors developed a measure of teacher beliefs about mathematics teaching and learning – the *IMAP Web-Based Beliefs Survey* (we used the same measure in the present study). They analyzed belief change in PSTs attending four different kinds of field experiences that focused on: 1) learning about children's mathematical thinking by watching videos, 2) watching videos about children's mathematical thinking and working directly with individual children on problem solving, 3) visiting teachers with classroom close to the university, or 4) visiting selected teachers identified as reform oriented. A control group did not undergo any experiences. Results indicate that PSTs who learned about children's mathematical thinking either through watching videos only, or through a combination of video analysis and direct work with children showed larger belief changes than all other PSTs. Interestingly, the belief change of the control group was larger than for the PSTs who visited typical mathematics classrooms, close to the university. The authors argue that experiences in these classrooms might contradict the beliefs that are promoted in university courses during teacher preparation. Thus this study's findings indicate that a focus on the analysis of children mathematical thinking during teacher preparation supports changes in beliefs. In addition, video can be used as an effective tool to change beliefs that can substitute PSTs direct work with children. Field experiences in classrooms that are not necessarily aligned with constructivist approaches to mathematics teaching, on the other hand, can be counterproductive. Accordingly, the authors argue for an approach to teacher preparation that a) controls for variables that might otherwise distract PSTs, b) maintains sufficiently authentic experiences that PSTs found relevant to their future work as teachers (as it can be done with video recordings), and c) provides PSTs opportunities for guided reflection (Philipp et al., 2007).

2 Study design

We build on the Philipp et al.'s study (2007) to examine the impact of a video-enhanced mathematics methods course on changes in PSTs' beliefs about mathematics teaching and learning. In order to compare our findings with the results of Philipp et al.'s (2007), we used the same instrument to measure PSTs beliefs (see Measure section).

This study is part of a larger project that includes an experimental design. Participants are PSTs enrolled in a teacher preparation program for elementary school teachers (teaching kindergarten through sixth grade, that is children from 5 to 12 years old) at a large public university in the United States. PSTs were randomly assigned to attend two 20-week mathematics methods courses that differed in their approach. Both mathematics methods courses were taught in the fall (mid-September till December) and winter (January till mid-March) quarters by expert instructors, who had several years of teaching experience both at primary-school and teacher-preparation levels.

The courses met for approximately 30 hours each quarter, structured in 3-hour weekly meetings. The experimental course, hereby named the *Learning from Mathematics Teaching (LMT) course*, made extensive use of video as a tool for developing PSTs' abilities to analyze teaching and students' learning. It combined activities that allowed the study and analysis of teaching with opportunities to practice student-centered teaching with students in classroom settings. Video was used to provide images of mathematics teaching that is responsive to student thinking and to facilitate a collaborative process of analysis. Similarly to the intervention in the Philipp et al.' study (2007), PSTs reviewed videos of individual students solving mathematics problems. In addition, the course included analyses of classroom teaching episodes. A framework tested in previous studies, the *Lesson Analysis Framework* (Santagata & Guarino, 2011) guided PSTs' collaborative analysis of student thinking, mathematical ideas, and the interrelation between teachers' decisions and student learning. As PSTs watched videos of classroom lessons, they were asked to attend to the following four sets of questions: 1) What is the main learning goal of this instructional episode? 2) Did the students make progress toward the learning goals? What evidence do we have that students made progress? What evidence do we have that students did not make progress? What evidence are we missing? 3) Which instructional strategies supported students' progress toward the learning goals and which did not? Finally 4) What alternative strategies could the teacher use? How do you expect these strategies to impact students' progress toward the lesson learning goals? If any evidence of student learning is missing, how could the teacher collect such evidence?

Video-enhanced tasks were planned to gradually scaffold PSTs from supported to independent analyses of teaching and from analyses of others' lessons to analysis of their own teaching. Thus, even though the development of PSTs' ability to analyze student thinking was a concern shared between our intervention and those designed by Philipp et al.'s (2007), our course was broader in scope in that, as a mathematics methods course, its ultimate objective was that of preparing teachers to teach mathematics and to reflect on their own teaching in productive ways.

It is plausible to think that, although PSTs' beliefs were not explicitly the focus of the video-enhanced collaborative analyses we designed, these analyses served as opportunities for PSTs to confront their beliefs about mathematics teaching and learning. This is the question we entertain in the present study. In a previous implementation of a similar curriculum, we found that PSTs spent a considerable amount of time during group discussions comparing the mathematics teaching approach promoted by the mathematics methods instructor and the approach they experienced as children. Over time statements that challenged the constructivist approach to mathematics teaching decreased and statements that embraced it increased in number (Santagata, Jovel & Yeh, under review).

The comparison course, hereby named the *Mathematics Methods Course (MMC)*, also promoted a constructivist and student-centered approach to mathematics teaching, but followed a more typical approach to mathematics methods instruction in the United States. It focused on developing teachers' mathematics content and pedagogy, problem-based instructional strategies, lesson planning, and assessments. Video was seldom used and PSTs did not engage in systematic analysis of student thinking and learning.

Both groups of PSTs completed a fieldwork experience while attending the math methods course and during the subsequent spring quarter (i.e., April through June). During the fall quarter they observed a master teacher once a week and engaged in brief, highly-supported teaching activities. During the winter quarter, they spent four days a week in the classroom and gradually assumed more teaching responsibility. During the spring quarter, they changed placement (moving to a higher grade level (4th–6th grade) if they were placed in a k-3 grade class during the fall and winter, or moving to a lower grade level if they were placed in an upper grade level class during the fall and winter) and assumed full responsibility for the class. Field placements were made randomly. It is thus plausible to assume that the quality of the placement (i.e., nature of support provided by the master teacher and teaching approach prevalent in the placement class) varied equally across groups.

3 Research questions

The present study focused on two sets of research questions:
1. What is the nature of PSTs' beliefs about mathematics teaching and learning prior to teacher preparation?
2. Do PSTs' beliefs change during teacher preparation? What is the nature of PSTs' beliefs at the end of teacher preparation in the two groups of participants? Are there significant group differences?

4 Measure

To measure beliefs, *the Integrating Mathematics and Pedagogy survey (IMAP)* developed by Ambrose et al. (2004) was used. Participants completed the survey prior to the beginning of the course and approximately three months after course completion (i.e., at the end of their spring student teaching placement). This is a web-based survey developed to assess prospective elementary teachers' beliefs about mathematics teaching and learning. The survey utilizes context-specific item prompts in a constructed response test format. It portrays complex classroom situations (either described through words and students' work or portrayed in video clips) involving students that capture the uncertainty of elementary classroom interactions. PSTs are asked to analyze and respond to these complex situations through a combination of close and open-ended items.

This approach to measuring teacher beliefs departs from more commonly used measures based on Likert-scale surveys. IMAP survey designers pointed out three issues with measures using Likert-scales only: 1) it is difficult to know how respondents interpret words used in the survey items, 2) survey responses do not provide information about the importance of a certain issue to respondents, and 3) little or no context is provided, leading to possible multiple interpretations of a statement. To address these issues and build on the most recent literature on teacher beliefs, the IMAP survey was designed to take into account the four characteristics of beliefs mentioned above: 1) beliefs influence perception, therefore surveys should include complex situations to interpret; 2) beliefs are dispositions to actions, therefore they can be inferred from ways respondents are disposed to act in a particular situation; 3) beliefs are held with differing intensities, therefore surveys should capture differing levels of evidence for a respondent's holding a belief; and 4) beliefs tend to be context-specific, thus surveys should situate questions in context and infer respondents' beliefs based on their interpretations on the situation (Philipp, 2007).

The beliefs targeted by the survey are phrased from a constructivist point of view. In this study, because of time issues we were not able to assess all seven IMAP beliefs. Instead we focused on the four that were most aligned with our intervention:

Belief 1: Mathematics is a web of interrelated concepts and procedures (and school mathematics should be too).

Belief 2: If students learn mathematical concepts before they learn procedures, they are more likely to understand the procedures when they learn them. If they learn the procedures first, they are less likely ever to learn the concepts.

Belief 3: Children can solve problems in novel ways before being taught how to solve such problems. Children in primary grades generally understand more mathematics and have more flexible solution strategies than adults expect.

Belief 4: During interactions related to the learning of mathematics, the teacher should allow the children to do as much of the thinking as possible.

Each belief is measured through a set of questions. For example, PSTs are asked to: evaluate student solution strategies to a problem and their connections and decide which strategies they would share in a class discussion and why; adopt the teacher's role and consider different strategies for multi-digit addition; select and justify an order for discussing particular strategies during a unit on multi-digit addition, including solutions that represented the standard algorithm and solutions that were more conceptual in nature; discuss whether a child could solve a particular novel problem on his own without a step-by-step explanation; and watch brief video clips of a student-teacher interaction and discuss the role of the teacher (who was portrayed to be very leading), and ways they would have structured the lesson, including whether they would have built on students' thinking to a greater extent than the observed teacher.

Responses are scored according to the instrument's manual (Philipp & Schappelle, 2003) and are assigned a score of 0 if interpreted as showing no evidence of the belief and the highest score possible (a score of 3 for Beliefs 1, 2, and 4 and a score of 4 for Belief 3) if they indicate (very) strong evidence of the belief. The combination of scores obtained in questions targeting a certain belief provide an overall score for that belief. The survey authors chose to use a maximum score of 4 for Belief 3 because of the wider range of teacher responses and levels of evidence that these provided.

Two independent raters scored all responses. Inter-rater reliability, measured as percent agreement, for all sets of questions was computed initially, at midpoint, and at the end of scoring and ranged from 80% to 95.8% across questions and time points. In case of disagreements, a third rater reviewed the response and made the final scoring decision.

5 Participants

The study participants included 112 elementary PSTs, two cohorts (2011/12 and 2012/13 academic years) of the one year post-bachelor teacher education program from which the participants were drawn. PSTs were randomly assigned to the LMT (N = 53) or the MMC group (N = 59). Differences in sample size are due to a few participants who left the program for health issues right after random assignment was completed or decided not to participate in the study. Of the 112 participants, 48 from the LMT and 47 from the MMC course had both pre and post survey data. Eighty-nine percent of the participants were female with an average age of 23.5 years (SD = 2.82 years). PSTs identified themselves as Caucasian American (47.3%), Asian American (39.3%), Latin American (8%), and other (5.4%). 51.4% held bachelor's degrees in the humanities, 45.0% in social sciences, 2.7% in business, 0.45% in biological sciences. Only one participant held a bachelor degree in mathematics. Finally, approximately half (47%) of the participants had no prior teaching experience. The rest had minimal teaching experiences (i.e. tutoring, coaching).

6 Results

In summarizing the study results we will answer the research questions one at a time. PSTs were randomly assigned to either the LMT or MMC course. Initially, differences in the incoming belief scores of PSTs in the LMT and MMC group were analyzed to assure that preconditions were equal in both groups. Mann-Whitney-U-Tests were used because of the skewness and ordinal structure of the data. The median was calculated for each belief. No differences between the LMT and MMC group prior to teacher preparation were found. All participants showed overall weak alignment with constructivist beliefs.

Figure 1 below presents the percentages of PSTs that showed different levels of alignment with each of the four measured beliefs at the beginning of teacher preparation. For Belief 1 (i.e., mathematics is a web of interrelated concepts and procedures; *Mdn* = 1.00) as well as Belief 3 (i.e., Children can solve problems in novel ways before being taught how to solve such problems. Children in primary grades generally understand more mathematics and have more flexible solution strategies than adults expect; *Mdn* = 1.00) most of the participants showed no or weak alignment. For Belief 2 (i.e., if students learn mathematical concepts before they learn procedures, they are more likely to understand the procedures when they learn them. If they learn the procedures first, they are less likely ever to learn the concepts; *Mdn* = 1.00), a little over half of the participants showed no evidence or weak evidence of alignment. Finally, for Belief 4 (i.e., during interactions related to the learning of mathematics, the teacher should allow the children to do as much of the thinking as possible; *Mdn* = 0.00) the least alignment was found (60% showed no evidence of alignment), making this belief an important one to focus on in teacher preparation.

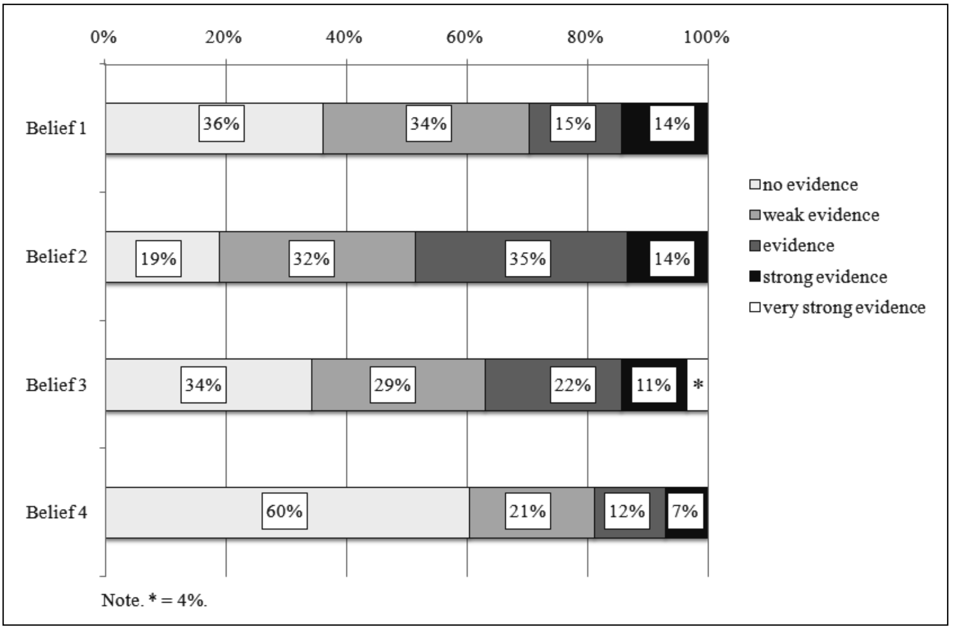

Figure 1 Percentage of participants who showed different levels of alignment with the beliefs measured by the IMAP survey at the beginning of teacher preparation

To assess changes in PSTs' beliefs during teacher preparation, Spearman correlations were performed for both LMT and MMC groups as a measure of score stability over time (see Table 1). All correlations were low and not significant; this showed that stability of scores was low. Consequently, scores changed considerably from the beginning to the end of teacher preparation.

Table 1 Spearman correlations between belief alignment prior to and at the end of teacher preparation for each group

	Belief 1	Belief 2	Belief 3	Belief 4
LMT group				
Corr. Coeff.	.010	.047	.165	−.003
MMC group				
Corr. Coeff.	.236	.036	.155	.073

Note: LMT group (N = 48), MMC group (N = 47); Spearman-Correlations, not significant.

To further assess these changes, change scores were calculated following the procedure suggested by Philipp et al. (2007, p. 453f.). Accordingly, PSTs (LMT vs. MMC group) were categorized into one of three groups based on their belief changes: 1) PSTs whose belief scores did not increase or decrease; 2) PSTs whose belief scores went up one level (small increase); and 3) PSTs whose belief scores went up two or more levels (large increase). The change scores are presented in Table 2.

Table 2 Belief changes by group and change score category

	No increase or decrease	Small increase	Large increase
Belief 1			
LMT group	38%	29%	33%
MMC group	45%	25%	30%
Belief 2			
LMT group	29%	35%	35%
MMC group	32%	34%	34%
Belief 3			
LMT group	35%	19%	46%
MMC group	40%	32%	28%
Belief 4			
LMT group	33%	35%	31%
MMC group	53%	28%	19%

Considerable changes were found for PSTs in both groups. Figure 2 shows the percentages of different levels of evidence in PSTs' alignment with the beliefs at the end of teacher preparation. Despite the fact that PSTs' beliefs changed in all four belief categories, the pattern of belief scores resembles the results from the pre-test: For Belief 1 (*Mdn* = 2.00) and Belief 3 (*Mdn* = 2.00) approximately one third of the participants still showed no or weak evidence of alignment. The alignment with Belief 4 (*Mdn* = 1.00) is still weaker than for all other beliefs, even though the percentage of PSTs who showed no alignment decreased by half (from 60% to 29%). Similarly to the pre-test results, in the post-test PST showed stronger alignment with Belief 2 (*Mdn* = 3.00) than with the other beliefs. Only very few PSTs showed no or weak alignment with this belief.

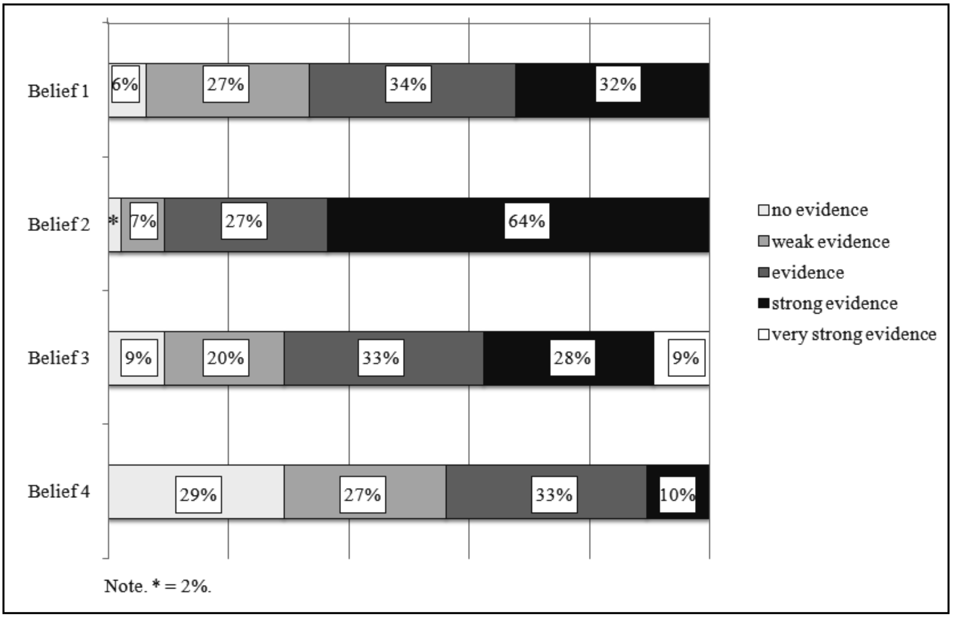

Figure 2 Percentage of participants who showed different levels of alignment with the beliefs measured by the IMAP survey at the end of teacher preparation

To test for LMT treatment effects, Mann-Whitney-U-Tests were used to look for differences at post test. One significant difference was found: the LMT group showed greater alignment with the belief that during interactions related to the learning of mathematics, the teacher should allow children to do as much of the thinking as possible (i.e., Belief 4). Results are displayed in Table 3. Eighteen percent of participants in the LMT group showed no evidence of alignment with the belief (40% in the MMC group); 31% showed weak evidence (23% in the MMC group); 33% showed evidence (34% in the MMC group); and 18% showed strong evidence of alignment with the belief, whereas only one participant of the MMC group aligned with the belief strongly.

Table 3 Median belief scores at the end of teacher preparation for each group

	Median			
	LMT	**MMC**	*U*	*p*
Belief 1	2	2	−0.866	.386
Belief 2	3	3	−1.198	.231
Belief 3	2	2	−0.763	.445
Belief 4	2	1	−2.510	.012

7 Discussion

Findings related to PSTs' incoming beliefs about mathematics teaching and learning confirmed previous studies that have found that prior to teacher preparation, teachers hold beliefs that are typical of a traditional and transmission point of view on teaching (Handal, 2003; Op't Eynde, de Corte, & Verschaffel, 2002). Specifically, the majority of PSTs in this study's sample did not conceive of mathematics as a web of interrelated concepts and procedures, did not think children can solve mathematics problems in novel ways before being presented with a procedure, and thought teachers should direct instruction. Particularly in relation to Belief 4 (i.e., during interactions related to the learning of mathematics, the teacher should allow the children to do as much of the thinking as possible), participants showed the least alignment, with 81% of them showing no or weak evidence of alignment with the belief.

Participants showed more alignment with the belief that if students learn mathematical concepts before they learn procedures, they are more likely to understand the procedures when they learn them. If they learn the procedures first, they are less likely ever to learn the concepts. Approximately 50% of them showed no or weak evidence of alignment with this belief, while the remaining 50% showed evidence or strong evidence of alignment.

In contrast to some prior studies that have found teacher beliefs to be highly stable (Benbow, 1995; Foss & Kleinsasser, 1996), in the present study, PSTs' beliefs changed during teacher preparation. Correlations of pre- and post-test data revealed that scores stability was low. PSTs from both LMT and MMC groups considerably improved their alignment with constructivist beliefs. This indicates that teacher preparation experiences might contribute to these changes.

Although the alignment of fieldwork placements to a constructivist approach to mathematics teaching most likely varied across the sample, overall beliefs changed significantly over time and both versions of the mathematics methods course were conducive to these changes. These findings complement those obtained by Philipp et al. (2007). Our study did not include a group of PSTs whose learning relied only on field experiences, thus we cannot confirm or disconfirm Philipp et al.'s (2007) results in that regard. Rather, our study was designed to study the impact of mathematics methods instruction on belief changes in situations in which fieldwork experiences cannot be controlled – a situation that is very common in U.S. teacher preparation programs. Thus the findings provide evidence that changes in beliefs are possible during teacher preparation even when the quality of fieldwork experiences cannot be evaluated.

Both versions of the mathematics methods courses facilitated changes in beliefs. One significant group difference was found: PSTs in the LMT group showed a greater change in alignment with the belief that the teacher should allow children to do as much of the thinking as possible. This is particularly interesting given that this was the belief with which participants aligned the least prior to teacher preparation, thus conceivably one of the most difficult beliefs to change. While the median score for the MMC at the end of teacher preparation was 1, the lowest among the belief scores at posttest, it equaled to 2 for the LMT group. Sixty-three percent of PSTs in the MMC group showed no or weak alignment with this belief compared to 49% of PSTs in the LMT group at the end of teacher preparation, and while 18% of LMT PSTs showed strong evidence of alignment, only one MMC PSTs fell in this category.

In addition, even though there were no significant group differences for Belief 3, the percentage of PSTs belonging to the different categories of change scores for this belief differed in the LMT and MMC groups: almost half of PSTs in the LMT group showed a large increase (46%) of alignment with this belief and only 28% of PSTs in the MMC group changed their belief to this extent (see Table 2).

Thus, notwithstanding variations in field placements which, given random assignment of participants to groups, most likely varied equally between groups, the video-enhanced course provided experiences that facilitated changes in Belief 4 (and to some extent in Belief 3) that were greater than the changes facilitated by the MMC course. To note is that in Philipp et al.'s study (2007) there were no significant differences in alignment changes with Belief 4 in groups who analyzed student thinking through video only, or a combination of video and controlled classroom visits, and the group who did not participate in these opportunities and did not complete fieldwork experiences (i.e., the control group). In other words, the monitored analysis of student thinking in their study did not make a difference for changes in this belief. At the same time, participating in field experiences only resulted to be detrimental (i.e., only small percentages of PSTs in their field experiences groups showed changes in this belief). Similarly, these authors did not find significant differences in Belief 3 changes for PSTs who participated in their video-enhanced experience and those belonging to the control group (while field experiences only were again detrimental). To the contrary, in the present study, for PSTs in the LMT both Belief 3 and Belief 4 changed to a greater extent than for PSTs in the MMC (and significantly so in the case of Belief 4) despite the fact that both groups participated in field experiences.

Both findings (i.e., belief changes in both groups and the group difference for Beliefs 3 and 4) are in contrast with results discussed by researchers who in their studies did not find changes in PSTs' beliefs during teacher preparation, such as Foss and

Kleinsasser (1996, p. 439), who argued that "regardless of what they are presented during their methods course, they [pre-service elementary teachers] begin and end with similar perceptions and beliefs about mathematics teaching and learning."

We think that video examples of successful lessons, in which children were shown solving problems in novel ways before their teachers taught them how to solve them and were allowed to make their thinking explicit through written work or discussions, gave PSTs confidence that this is a feasible and effective approach to mathematics teaching, even in cases in which they were not able to observe this approach during fieldwork and were exposed to more tradition teacher-centered teaching. Perhaps an important difference between our intervention and that investigated in Philipp et al.'s study (2007) is that we utilized several videos in which children were portrayed explaining their thinking and solving problems in the contexts of classroom lessons, thus providing images closer to the reality of everyday teaching than those portrayed in video of students solving mathematics problems individually in front of an interviewer.

The structured analysis and collaborative discussion of these videos also most likely contributed to changes in this belief. Discussions often allow teachers to become aware of their assumptions about teaching and learning as they confront them with those held by others. Awareness is an important first step in changing one's beliefs. Finally, the opportunity to experiment with this type of teaching approach and to reflect on student thinking as portrayed in video of one's own teaching might have influenced participants' belief change as well.

Our data does not allow us to distinguish among all these potential contributing factors. These are thus only hypotheses that could be further explored in the future through interviews with participating PSTs or through studies that control for various factors. Nonetheless this study's findings provide important evidence in support of the use of guided and collaborative analysis of video of classroom lessons in teacher preparation. Belief 4 is particularly crucial within a constructivist approach to teaching: When teachers direct instruction to a great extent and do not provide opportunities for children to make their mathematical thinking visible, it is hard for them to truly build on children's initial understandings as promoted by constructivist approaches.

On the other hand, the video-enhanced course did not provide any additional advantage to PSTs in relation to the other two beliefs that were measured in this study. Both courses (despite variations in individual teachers' field placements) were equally effective at increasing alignment with the beliefs that: 1) Mathematics is a web of interrelated concepts and procedures (and school mathematics should be too); 2) If students learn mathematical concepts before they learn procedures, they are more likely to understand the procedures when they learn them. If they learn the procedures first, they are less likely ever to learn the concepts. This indicates that the analysis of videos of classroom lessons might be less important in relation to these beliefs and other opportunities to learn about conceptually-driven mathematics teaching might be as beneficial.

8 Implications and future directions

Various implications for the practice of teacher preparation can be drawn from this study's results. Differences in incoming beliefs should be assessed by method instructors at the beginning of teacher preparation. Discussion groups could then be created that involve PSTs with different beliefs to facilitate confrontation. This would also help future teachers become aware of their beliefs, a first important step in working toward belief change. In addition, specific learning activities could be designed for PSTs who show the least alignment with constructivist beliefs.

When addressing beliefs most closely related to classroom practice, such as belief 4 in this study, video seems to be a promising tool to offer PSTs concrete images of successful examples of constructivist teaching. Accompanying analysis and reflection activities can further facilitate changes in these types of beliefs.

An important next step of this research will be to examine participants' beliefs over time. Research suggests that although PSTs may develop progressive beliefs during teacher preparation, they fall back into more traditional beliefs once they enter the profession (Müller-Fohrbrodt, Cloetta, & Dann, 1978). It will be thus interesting to examine participants' beliefs during the first few years of teaching as part of the longitudinal component of the larger project. Finally, another important question is whether an alignment with constructivist beliefs results in student-centered teaching practices. This is a question we plan to pursue in future research.

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Sonja Mohr
Technical University of Berlin, Humanities, Institute of Education,
Department of Educational Psychology
Marchstr. 23, 10587 Berlin, Germany
sonja.mohr@tu-berlin.de

Rossella Santagata
University of California, School of Education, Irvine
3200 Education Building, Irvine, CA 92697, USA
r.santagata@uci.edu

Case-Based Learning in Initial Teacher Education: Assessing the Benefits and Challenges of Working with Student Videos and Other Teachers' Videos[1]

Kathrin Krammer, Isabelle Hugener,
Manuela Frommelt,
Gabriela Fürrer Auf der Maur,
Sandro Biaggi

University of Teacher Education Lucerne, Switzerland

Abstract: The ability to analyze classroom situations proficiently is regarded as one of the key prerequisites for successful teaching. Although a steadily increasing body of empirical evidence proves that case-based learning with videos can foster professional vision in teachers, it is still necessary to gain a better understanding as to what type of video (one's own or those of other teachers) is especially impactful in initial teacher education. Against this background, we conducted the intervention study VideA ("**Vid**eo **A**nalysis in Teacher Education") in the first year of a Swiss teacher preparation program, whose chief aim consisted in promoting pre-service teachers' professional vision. Concretely speaking, we compared the students' (N = 159) and their facilitators' (N = 26) assessments of case-based learning with their own and other teachers' videos in terms of self-reported acceptance and effectiveness. Three seminar groups of about 18 second-semester students analyzed videos of their own teaching (Intervention A; n = 56), while three other seminar groups of about the same size analyzed videos of other teachers unknown to them (Intervention B; n = 51). The analyses were moderated by facilitators and supported with supplementary materials originating from the videotaped lessons. Acting as a control group, students in a further three seminar groups solely analyzed written teaching and learning materials, and did not make use of videos altogether (n = 52). The results show that the students' as well as the facilitators' ratings are quite high, irrespective of the examples of actual teaching practice used. Yet a comparison of the two video settings revealed that learning with one's own videos received a higher degree of acceptance from both the students and the facilitators than working with other teachers' videos. The same applies to effectiveness, which got slightly higher ratings in Intervention A than in Intervention B.

Keywords: teacher education, professional vision, case-based learning, lesson analysis, different types of classroom videos

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A steadily increasing body of research demonstrates that classroom videos can be a powerful tool in teacher education (e.g. Blomberg et al., 2013; Goeze et al., 2014; Janik & Seidel, 2009; Santagata, 2014; Seidel, Blomberg, & Renkl, 2013; Sherin & van Es, 2009). However, despite their considerable media-specific potentials, many questions are still open, so that there is a persistent need for further substantiated knowledge about the effects and conditions of learning with videos. As a case in point, the question as to how professional competences of teachers develop as a function of video-based reflection on their own versus others' teaching is still largely unanswered (Seidel et al., 2011; Zhang et al., 2011), and even completely uninvestigated in the field of *initial* teacher education. Here the intervention project VideA (*Vide*o *A*nalysis in Teacher Education) comes in, whose aim consists in promoting pre-service teachers' professional vision with respect to three selected basic features of effective teaching, and in gaining new insights into the effects and processes of learning with videos. After the completion of the intervention, the participating pre-service teachers and their facilitators assessed their experiences with videos in terms of acceptance and effectiveness (Krammer & Hugener, 2014). In what follows, we expound the theoretical background of case-based learning with different types of video, present our intervention study in detail and report selected results. After the interpretation of our findings we conclude by highlighting specific benefits and challenges of learning with student videos and other teachers' videos in initial teacher education.

1 Learning with videos in teacher education

The ability to analyze classroom situations in a proficient way is generally regarded as a key prerequisite for successful teaching (Sherin, Jacobs, & Philipp, 2011). It comprises competence in noticing and interpreting classroom situations, and is referred to as "professional vision" (Seidel & Stürmer, 2014; Sherin & van Es, 2005). Professional vision requires conceptual knowledge about the conditions of effective teaching as well as the ability to apply this knowledge in actual practice (Stürmer, Könings, & Seidel, 2013). Recent research findings, which provide evidence for a correlation between professional vision and successful teaching, clearly underpin the importance of this specific ability (Kersting et al., 2012; Sherin & van Es, 2009). Thus, as approaches that make use of case-based learning with videos have already proved to foster professional vision (Santagata & Guarino, 2011; Stürmer et al., 2013), they can also be assumed to offer a promising way of establishing the essential link between theory and practice (Blomberg et al., 2013; Brophy, 2004). Although most projects conducted on learning with videos were embedded in professional development programs (e.g. Borko et al., 2008; Krammer et al., 2006; Sherin & van Es, 2009), there are also encouraging findings for initial teacher education, which point to the potential of promoting the professional vision even in pre-service teachers (e.g. Goeze et al., 2014; Gold, Förster, & Holodynski, 2013; Santagata & Guarino, 2011; Seidel et al., 2013; Star & Strickland, 2008; Stürmer et al., 2013).

Up to now, though, only a few research projects have pursued the question of how professional competences of teachers develop alongside video-based reflection on their own versus other teachers' teaching, and there are even no findings at all on this specific issue as far as initial teacher education is concerned. However, currently available results from studies with practicing teachers indicate that they deem their own classroom videos more authentic and motivating than videos of other teachers, which, by contrast, tend to be commented on in a more elaborated and detailed, but also more critical way (Kleinknecht & Schneider, 2013; Seidel et al., 2011; Zhang et al., 2011). Whereas videos of one's own teaching support reflection and discussion on personal experiences, other teachers' videos provide the opportunity to focus attention systematically on observing and interpreting the realization of particular basic features of effective teaching (Baecher et al., 2013).

1.1 Focal points of working with one's own videos

In many professional development projects which work with classroom videos, the activities are based on sequences that document the participants' own teaching. Such recordings usually prepare the ground for guided reflection and discussion on one's own experiences, in which reference to personal questions on instructional issues constitutes a valuable basis for the feedback of colleagues on one's individual teaching behavior (Baecher et al., 2013; Krammer, 2014; Krammer, Hugener, & Biaggi, 2012). In comparison with videos of unknown classrooms it seems that analyzing one's own teaching increases the extent of emotional involvement, and allows the participants to relate themselves to the situation more vividly (Borko et al., 2008; Kleinknecht & Schneider, 2013). At the same time, however, working with one's own videos can evoke negative emotions that affect self-esteem, especially in relatively young and inexperienced teachers (Kleinknecht & Poschinski, 2014).

Against this general background the question arises whether this specific form of learning can already be productively implemented in initial teacher education. For though its potential for initiating active involvement proves to be quite high, there is also the danger that repeated observation and discussion of sequences that are taught by novices provides too little stimulus for the development of professional competences, and thus might further the adoption of suboptimal teaching behaviors. The paramount aim of working with students' own classroom videos should therefore consist in a theoretically substantiated reflection on the effects of their individual teaching behavior on pupil learning, and in developing alternative pedagogical strategies on the basis of conceptual knowledge about effective teaching.

1.2 Focal points of working with other teachers' videos

Working with other teachers' videos makes it possible to illustrate and analyze realizations of particular teaching behaviors, which novices are usually not able to perform themselves yet (Biaggi, Krammer, & Hugener, 2013). Among others, videos of unknown teachers offer the opportunity to make the students' observations more sensitive to selected relevant features of classroom teaching (Borko et al., 2011). As recent findings indicate, it seems likely that the analysis of other teachers' videos provides more stimulus for developing new perspectives on classroom teaching and for coming up with alternative interpretations than dealing with one's own videos (Kleinknecht & Schneider, 2013; Seidel et al., 2011). Nevertheless, also this way of working with videos inevitably arouses positive as well as negative emotions (Kleinknecht & Poschinski, 2014), which needs to be taken into account.

When following this approach, facilitators are in the position to direct the course of the discussions more tightly, and to promote the further development of the students' teaching behavior in a systematical way. At the same time, the facilitators should make sure that the students do not prejudge the teaching sequences under consideration, and that they do not adopt certain ways of acting without reflection. Therefore, the main purpose of working with videos of other teachers is once again to reflect on potential effects of teaching actions, and to suggest viable alternative strategies to enhance pupil learning, both based on profound conceptual knowledge about effective teaching.

2 Method

2.1 Aim of the study

The overall aim of the intervention study to be presented below was to increase the understanding of how case-based learning with different examples of actual teaching practice supports pre-service teachers' professional vision. As a prime research interest we investigated the use of videos recording the students' own teaching in comparison with other teachers' videos. The intervention was specifically designed to foster pre-service teachers' professional vision with respect to three basic features of effective classroom teaching which are deemed relevant to pupil learning irrespective of subject and grade (Helmke, 2009; Stürmer et al., 2013): the first feature *goal clarity* includes transparency about goals and requirements as well as a clear lesson structure, while the second feature *teacher support* refers to process-oriented support of learning processes that is based on open questions, scaffolds and adaptive feedback, thus encouraging reflection. The third feature consists in the creation of a *positive learning climate*, to which aspects like humor and appreciation are essential.

The analyses pertaining to the effects of the intervention on the development of the students' professional vision are at the center of currently ongoing research. So in this paper, we pursue the questions as to whether the facilitators assess the elements of the intervention as useful, and as to whether both the facilitators and the students accept case-based learning with examples of actual teaching practice and regard it as an effective means of learning. Making reference to expectancy-value models it is reasonable to suppose that facilitators as well as students are willing to engage actively in video-aided seminars when they expect the method to be goal-directed, and consider the learning opportunity to be supportive (Lipowsky, 2011). Thus, the facilitators' positive perception of the usefulness of the elements of the intervention, and positive acceptance and effectiveness ratings of both facilitators and students are a crucial precondition for creating and using video-based learning environments to foster professional vision, and ultimately for a permanent implementation of videos in teacher preparation programs.

Taking these general considerations into account, we focus the remainder of our paper primarily on the following elementary research questions:

1. Do the facilitators assess the elements of the intervention as being useful?
2. Does case-based learning with examples of actual teaching practice meet with the acceptance of the participating students and facilitators?
3. Do students and facilitators assess case-based learning with examples of actual teaching practice as being effective?

2.2 Sample

The study VideA was conducted in the first year of a teacher preparation program for pre-primary, primary or secondary level teaching at the University of Teacher Education Lucerne, Switzerland. Nine seminar groups participated in the project and were each attended to by a team of facilitators.

Students

The sample of the intervention consisted of a total of 163 students. On average, they were 21.74 (SD = 2.01) years old; 127 (77.9%) of them were female and 36 (22.1%) male. The students' participation in the intervention was mandatory, but they were randomly assigned to one of the three settings of case-based learning (Intervention A: student videos; Intervention B: other teachers' videos; Control Group: written teaching materials, see *Structure of the intervention workshops*). Nonetheless, the two intervention groups and the control group are comparable with respect to age, sex and the school level they were being prepared for. As four students did not complete the questionnaire (see 2.4), our findings are based on 159 valid cases.

The evaluation of a scale from Drechsel (2001), which assesses interest in the topic of teaching and learning on a range between 1 (very low) and 6 (very high), showed that the students in our sample entered the first semester of their teacher preparation program with a high level of interest in teaching and learning (M = 4.32, SD = 0.64), and that the three intervention settings did not differ in this respect (F = 1.21, df = 2, p > 0.05). Moreover, there is no significant correlation between the students' interest in the topic of teaching and learning and their acceptance and effectiveness ratings to be reported in the results section below.

Facilitators

The weekly intervention workshops were run by a total of 17 (65.4%) female and nine (34.6%) male facilitators. All of them were certified teachers who held a diploma in teaching, with their average practical teaching experience amounting to 12.96 years (*SD* = 6.47). 18 facilitators were current teachers and supervising teachers with an additional qualification in adult education. The other nine facilitators were in possession of a university degree in educational science or psychology, and at the same time lecturers at the University of Teacher Education Lucerne.

All of the nine participating seminar groups with approximately 18 students were attended to by a team of three facilitators: two supervising teachers and one graduate lecturer. Each team participated voluntarily and was randomely assigned to one of the three intervention settings. In consequence, nine facilitators based their workshops on student videos, and eight dealt with other teachers' videos, while the nine control group facilitators made use of written teaching and learning materials. Whereas the facilitators in charge of the video intervention groups did not differ with respect to their overall experience in teaching at the University of Teacher Education (student videos: $M = 3.39$, $SD = 3.18$, $n = 9$; other teachers' videos: $M = 2.81$, $SD = 1.81$, $n = 8$), there was a difference ($U = 15.5$, $p < 0.05$) between the facilitators working with other teachers' videos and the ones working with written teaching and learning materials, since the latter had more experience on average (written materials: $M = 6.00$, $SD = 3.16$, $n = 9$).

In a three-day session, a total of 27 facilitators were trained on the content and the structure of the intervention, and on the Lesson Analysis Framework (see *Procedure of the video analysis*). Thereafter, they were ready for their workshops with the students. One facilitator did not complete the questionnaire (see *2.4*) for health reasons, so that all in all there are 26 valid cases available for the purpose of evaluation.

2.3 Description of the intervention

In first year of the full time preparation program, all students follow the same curriculum, which mainly covers educational psychology, general pedagogy and subject-specific pedagogy (dealing with subjects like mathematics, languages, biology, and history). The intervention was implemented as part of a mandatory course in the second semester that dealt with general teaching skills and techniques. In the following subsections, we describe the structure of the intervention workshops, the selection of videos and supplementary materials, the procedure of the video analysis, and finally the training of the facilitators

Structure of the intervention workshops

The theoretical background of the three basic features of effective classroom teaching (goal clarity, teacher support, and positive learning climate) mentioned in section *2.1* was introduced right in the first week of the second semester. All participating students received study notes with a description of the features to be focused on and examples of how to put them into practice. These conceptual inputs prepared the ground for the subsequent analyses of concrete realizations in examples of actual teaching practice, which took 90 minutes every week (Table 1). These weekly analyses were conducted in a total of nine groups which had been assigned to one of three specific intervention settings by lot. Three groups of about 18 students worked with *videos of their own teaching* (n = 57 students) which had been recorded during their teaching practice, while three other groups worked with *videos of other teachers* (unknown to them), which had been preselected by the facilitators (n = 53 students). By contrast, three groups did not work with videos at all, but made use of *written teaching and learning materials,* yet dealing with the same issues (n = 53 students). The workshops were usually organized in a half-group setting (about nine students) and each run under the responsibility of one facilitator.

Table 1 Workshop structure in the three intervention settings (one workshop per week; LAF = Lesson Analysis Framework)

Step	Duration	Intervention A	Intervention B	Control Group
1	90′	Analysis of the students' own videos with LAF n = 57	Analysis of other teachers' videos with LAF n = 53	Analysis of written teaching and learning materials with LAF n = 53
2	20′	Consolidation: learning journal entries		
3	30′	Transfer: lesson planning		

After each 90-minute analysis the students documented their main insights in a learning journal[2] for about 20 minutes, derived inputs for their own teaching practice, and substantiated them by referring to their theoretical knowledge about effective teaching. This way, the learning journal entries served the purpose of consolidating the newly gained insights. In the last 30 minutes of the workshop, the students finally had to plan their next teaching practice, which enabled them to apply their fresh knowledge immediately to a realistic and personally relevant scenario. In accordance with Step 1 of the Lesson Analysis Framework (LAF, see *Procedure of the video analysis*), they first analyzed contents, learning goals and potential barriers to comprehension, and then moved on to concrete planning activities in preparation for their forthcoming lessons.

Selection of student videos and supplementary materials

In groups who worked with *videos of their own teaching*, the facilitators supported the students in the process of video selection. To prepare the facilitators for this

2 These learning journal entries are presently being analyzed in Sandro Biaggi's PhD-project (Biaggi, Krammer, & Hugener, 2014), whose findings will be published later on.

specific kind of assistance, the research team provided a careful introduction and supplied them with the assignments which had been created to guide the students in editing a couple of sequences from their own classroom. The students were filmed by the facilitators or fellow students in the course of their teaching practice. Thereafter they were to select one or more sequences from these lesson recordings. Altogether, the sequences had to last between 6 and 12 minutes and were supposed to pertain to one of the three basic features of effective teaching (goal clarity, teacher support or positive learning climate). The video sequences could optionally be taken from the subjects mathematics, natural sciences, geography, history or languages (German, English, French). When deciding on the sequences, the students made sure that the classroom dialogues were clearly audible and visible. Moreover, they were asked to gather supplementary materials (e.g. lesson plans in which the selected sequences were marked, assignments, contents covered in the lesson, work outcomes of the pupils), which were intended to support the reconstruction and the understanding of the recorded teaching and learning processes during the analysis.

Selection of other teachers' videos and supplementary materials

For the groups who were supposed to analyze *other teachers' videos*, the research team had compiled suitable sequences from already existing classroom videos with supplementary materials in advance. Again, the selected classroom videos originated from the subjects mathematics, natural sciences, geography, history or languages (German, English, French). The main criterion for the selection was that the videos were well-suited for the purpose of analyzing classroom teaching with respect to the three basic features of effective teaching (goal clarity, teacher support or positive learning climate). It is important to note that the videos were not intended to act as particularly excellent examples. Rather, they had to contain the realization of at least one of the three focused features in a clearly observable fashion. Hence, all of the selected sequences allowed the students not only to notice certain indicators, e.g. of goal clarity, but also to develop and put forward suggestions for, say, enhancing the transparency of the goals to be achieved in class. For each workshop the facilitators chose one of the preselected videos of which they showed sequences of approximately 6 to 12 minutes in length to their group. Together with the videos, the facilitators provided supplementary materials which made it easier to embed the selected sequences in the course of the lesson as a whole, to identify its objectives, to reconstruct classroom interactions, and eventually to make sense of the pupils' work outcomes. In their entirety, these additional media prepared the ground for a profound discussion about the teaching situations with respect to their effects on the pupils' learning processes.

Procedure of the video analysis: LAF

As attentively guided joint discussions are crucial for successful case-based learning with videos (Borko et al., 2008; van Es et al., 2014), the facilitators moderated the group analysis along the lines of the *Lesson Analysis Framework* (LAF; Santagata & Guarino, 2011). The LAF directs the focus of attention on the pupils' learning and understanding processes, and encourages the students to substantiate their feedbacks by explicitly linking them to theory (Biaggi et al., 2013). In more detail, the framework consists of four analytical steps:

Step 1: So as to prepare the ground for the discussion, the *contents* covered in the lesson, the *learning goals* and the *expectations* set for the pupils are identified and, if need be, clarified. By studying lesson plans and assignments, the students familiarize themselves with the overall situation and the tasks to be completed. This allows them to define the demands on the pupils and to anticipate potential barriers to understanding.

Step 2: The students observe and describe the *pupils' behavior* and formulate hypotheses about their current level of understanding. In addition to the videos, copies of the pupils' work (e.g. completed worksheets) or transcribed teacher-student interactions support the reconstruction of the learning and understanding processes, and thus form an integral part of the basis for this analytical step.

Step 3: The students focus on the *teacher's actions* and come up with hypotheses about their *effects on the pupils' learning processes*. While doing so, they are repeatedly asked to relate their comments and assessments concerning the realization of important aspects like goal orientation, learning assistance, and classroom atmosphere to concrete video observations. Moreover, they are expected to produce reasons for assumed connections between the teacher's actions and the pupils' learning by drawing on their conceptual knowledge about the basic features of effective teaching.

Step 4: The students *develop improvements in teaching* and alternative strategies with respect to the basic features of effective teaching for which they provide theoretically substantiated reasons.

Training of the facilitators

In preparation for their task, all of the participating facilitators received a three-day introduction to the theoretical background assumptions and the method of case-based learning with examples of actual teaching practice previous to the beginning of the intervention. The preparatory training sessions dealt with the following subgoals:

1. acquiring conceptual knowledge about the three basic features of effective teaching in focus (goal clarity, teacher support, and positive learning climate);
2. developing viable ways of realizing basic features of effective teaching, and analyzing them in concrete examples derived from practice (video recordings, teaching and learning materials);
3. being able to moderate the analysis of examples of actual teaching practice along the lines of the four steps of the LAF (Santagata & Guarino, 2011);

4. being capable of supporting the students in their lesson planning and learning journal activities with the aim of consolidating and transferring newly acquired knowledge.

This preparatory training was scheduled one month before the beginning of the intervention, with the last session taking place about one week in advance. Apart from that, the facilitators were twice visited by a member of the research team during the implementation of the intervention. The purpose of these visits was to give them follow-up training, and to advise them on the moderation of the joint analyses along the lines of the LAF. In order to check the implementation of the intervention, the facilitators were filmed in class.

2.4 Data collection

At the end of the intervention, both the students and the facilitators were asked to complete a questionnaire. The items and scales had been taken from Lipowsky et al. (2010), and adapted to evaluate acceptance and effectiveness of case-based learning with examples of actual teaching practice. Each participant was supposed to rate the questions on a four-point Likert scale, so that all of the responses could be scored at a range between 1 and 4 of the following format: 1 = Disagree; 2 = Somewhat disagree; 3 = Somewhat agree; 4 = Agree. In addition, the facilitators were given the opportunity to comment on their ratings in an open answer format.

As owing to the small sample (N = 26) it was not possible to identify scales in the facilitators' questionnaire, the respective results are presented as group values (M, SD) at the level of single items.

3 Results

3.1 Facilitator assessments of the elements of the intervention

Only the *facilitators* were asked to evaluate the items covering the single elements of the intervention and the study notes used to introduce the basic features of effective teaching. Their assessments turned out to be high in all three intervention settings (student videos, other teachers' videos, written teaching materials; see Table 2). All of them (video groups and control group) considered the basic features of effective classroom teaching in focus as relevant and, in particular, qualified the examples included in the study notes as helpful. In their opinion, case-based learning (with videos or written teaching materials) forms a suitable basis for analyzing and discussing the concrete realization of the three selected features, in which notably case-based learning *with videos* seems to attract the facilitators' interest. As far as this latter way of learning is concerned, other teachers' videos were deemed especially suited for discussing questions of how to arrange lessons, whereas the facilitators working with the students' own videos were particularly well able to be responsive to and deal with their group's questions and interests. By contrast, the facilitators saw only little leeway for the overall conception of their workshops, because the contents and the procedure of the intervention had been predefined by the research team.

Table 2 Items evaluating different elements of the intervention: facilitator assessments

Items	Student videos (n = 9) *M* (*SD*)	Other teachers' videos (n = 8) *M* (*SD*)	Teaching materials (n = 9) *M* (*SD*)
The study notes on features of effective teaching cover relevant theoretical basics for first-year students.	4.00 (.00)	3.75 (.46)	4.00 (.00)
The study notes on features of effective teaching contain helpful examples for the practical realization of basic features of effective teaching.	3.75 (.46)	3.71 (.49)	3.67 (.50)
The examples of actual teaching practice (videos, written materials) provided a suitable basis for discussions on the basic features of effective teaching.	3.33 (.50)	3.50 (.53)	3.33 (.50)
I consider teaching with examples of actual teaching practice as interesting.	3.67 (.50)	3.75 (.46)	3.00 (.50)
The examples of actual teaching practice provided a suitable basis for reflections on questions addressing lesson arrangement.	3.00 (.50)	3.63 (.52)	3.13 (.35)
I was able to be responsive to and to deal with the students' questions and interests in a sufficient way.	3.38 (.74)	2.75 (.70)	2.44 (.73)
Case-based learning gave me enough leeway for designing the course stimulatingly and with a lot of variation.	2.33 (.50)	2.50 (1.06)	2.33 (.50)

3.2 Acceptance of case-based learning

Both the facilitators and the students were questioned about their acceptance of case-based learning with examples of actual teaching practice, which was done by means of seven items such as "The examples of actual teaching practice provided a suitable basis for discussions about teaching." In the student questionnaire, the internal consistency of this scale amounted to α = .79.

The participating *students* reported a rather high degree of acceptance of learning with videos (*Table 3*), the comparison of the group means being significant (F = 3.12, df = 2, p = .047). Scheffé's post-hoc test reveals that acceptance as reported by students who had worked with their own videos was slightly higher than acceptance as reported by students who had worked with other teachers' videos. The effect is small to medium ($\eta 2$ = .038).

Table 3 Acceptance of case-based learning: student assessment scale

Scale	Student videos (*n* = 56) *M* (*SD*)	Other teachers' videos (*n* = 51) *M* (*SD*)	Teaching materials (*n* = 52) *M* (*SD*)
Acceptance of case-based learning with examples of actual teaching practice	3.08 (.50)	2.87 (.36)	2.97 (.43)

Student videos > other teachers' videos* ($p < .05$).

The *facilitators'* ratings of their acceptance of case-based learning are also quite high, but show no significant group differences (*Table 4*). In sum, the analysis of examples of actual teaching practice is regarded as providing a very suitable basis for fruitful discussions about teaching. Furthermore, our analyses indicate that the LAF is perceived as a useful means in this process.

Table 4 Items evaluating the acceptance of case-based learning: facilitator assessments

Item	Student videos (*n* = 9) *M* (*SD*)	Other teachers' videos (*n* = 8) *M* (*SD*)	Teaching materials (*n* = 9) *M* (*SD*)
The analysis of examples of actual teaching practice encouraged the students to reflect on their own teaching.	3.67 (.50)	3.13 (.35)	3.22 (.67)
The examples of actual teaching practice provided a suitable basis for discussions about teaching.	3.78 (.44)	3.75 (.46)	3.22 (.53)
The analysis of examples of actual teaching practice sharpened the students' view on teaching.	3.89 (.44)	3.00 (.00)	3.57 (.53)
The questions of the Lesson Analysis Framework (LAF) were helpful for scaffolding the analysis.	3.78 (.44)	3.50 (.53)	3.67 (.50)
Case-based learning was helpful for dealing with the course contents in depth.	3.13 (.83)	2.86 (.64)	2.86 (.64)

3.4 Effectiveness of case-based learning

Both the facilitators and the students were asked to assess the effectiveness of case-based learning with examples of actual teaching practice. In the case of the *students*, effectiveness was rated by means of a five-item scale with an internal consistency of $\alpha = .70$ and questions like "Our collaborative analysis of examples of actual teaching practice gave me new inputs for my own teaching." As our analyses show, the students reported a rather high degree of effectiveness (*Table 5*). The comparison of the group means was not significant.

Table 5 Effectiveness of case-based learning: student assessment scale

Scale	Student videos (*n* = 56) *M* (*SD*)	Other teachers' videos (*n* = 51) *M* (*SD*)	Teaching materials (*n* = 52) *M* (*SD*)
Effectiveness of case-based learning with examples of actual teaching practice	2.94 (.49)	2.84 (.48)	2.83 (.40)

On the whole, the f*acilitators* rated the effectiveness of case-based learning with examples of teaching higher (*Table 6*) than the students did. Concretely speaking they got the impression that at the end of the intervention the students were better able to link conceptual aspects and teaching situations, to focus on the pupils' learning processes, and to provide knowledge-based reasons for the observed basic features of effective teaching than they had been before. In general, case-based learning with the students' own videos is considered to be particularly conducive to their individual competency development.

Table 6 Items evaluating the effectiveness of case-based learning: facilitator assessments

Items Through the joint analysis of examples of actual teaching practice …	Student videos (*n* = 9) *M* (*SD*)	Other teachers' videos (*n* = 8) *M* (*SD*)	Teaching materials (*n* = 9) *M* (*SD*)
… the students' professional competency development was promoted.	3.78 (.44)	3.38 (.52)	3.33 (.50)
… the students were given new inputs for their own teaching.	3.00 (.70)	3.25 (.46)	2.67 (.71)
… the students became acquainted with other perspectives on teaching.	3.56 (.53)	3.25 (.46)	3.33 (.71)
… the students' teaching behavior changed.	3.33 (.67)	2.75 (.46)	3.11 (.78)
… the students learnt to be more strongly aware of the pupils' learning processes and learning paths.	3.56 (.73)	3.13 (.83)	3.56 (.53)
… the students learnt to better relate conceptual aspects and teaching situations (link between theory and practice).	3.11 (.33)	3.00 (.76)	3.33 (.70)
… the students learnt to provide theoretically substantiated reasons for their feedback on teaching (e.g. how an open question may support pupil learning).	3.33 (.71)	3.25 (.46)	3.11 (.60)

4 Interpretation

Based on the answers obtained from the student and facilitator questionnaires, we are able to present some first insights with respect to the potentials and challenges as well as the conditions under which learning with classroom videos in initial teacher education can be successful. In what follows, the quantitative findings are for illustrative purposes complemented by a selection of written comments which the facilitators made in addition to their ratings in the questionnaire.

To begin with, we can state that the facilitators of all three intervention settings thought the elements of the intervention (basic features of effective teaching, study notes, examples) to be useful. On the one hand, this assessment can retrospectively be regarded as having provided an advantageous basis for the successful implementation of the three intervention settings. On the other hand, knowing this is of value to the interpretation of the results, because it ensures that differences in the acceptance and effectiveness ratings are not due to and can thus not be explained by varying perceptions of the usefulness of the elements in the three intervention groups.

In general, the facilitators seem to consider teaching with videos more interesting than teaching with written teaching and learning materials, and their assessments of video-supported case-based learning in terms of acceptance and effectiveness tend to be higher than those of the students. Although learning with the students' own videos meets with the highest degree of acceptance, a comparison with learning with other teachers' videos reveals that the differences are not significant, and that the facilitators' written comments equally mention specific potentials as well as challenges of both types of video.

The assessments of the facilitators and the students who had worked with *their own videos* proved to be quite high and indicate that this way of learning is regarded as being particularly conducive to competency development. Furthermore, working with student videos is deemed especially helpful when it comes to deal with the questions and interests of the group, and, besides, seems to be highly motivating and stimulating. Accordingly, the facilitators perceived their students to be "keen to discuss with their fellow students, as well as open, frank and appreciative in their feedback." Another facilitator commented on the students' involvement as follows:

> The students showed great interest in discussing examples of teaching, looked forward to watching their colleagues' videos, and were happy to receive feedback on their own videos. They appreciated that they got the opportunity to gain some insights into their colleagues' classrooms, and these mutual insights increased participation in discussions.

In accordance with these statements, findings from other studies corroborate that the participants' own videos are usually perceived as being very authentic and therefore stimulating (Kleinknecht & Schneider, 2013; Seidel et al., 2011; Zhang et al., 2011).

Despite their very positive overall assessment of working with student videos, the facilitators found it rather challenging to link the questions raised by individual group members to the basic features of effective teaching. The connection between the three features under consideration and the videos had to be established beforehand, which resulted in increased preparation efforts. As the facilitators were not able to watch the video sequences prior to the workshop in every single case, it was occasionally quite demanding for them to guide the discussions in terms of content. Further challenges were located in a variety of issues, e.g. that the students had not always chosen suitable video sequences, that the sometimes poor sound quality of the videos made it difficult to understand the classroom dialogues, or that not all of the group members supplied sufficient supplementary materials, although these were supposed to make it easier to discuss the sequences also with respect to their effects on the pupils' learning processes.

Turning to learning with *other teachers' videos*, we can generally conclude that it was also appreciated, and thought of as promoting the development of teaching competencies in a similar vein. Owing to the greater inner distance to other teachers' classroom videos, the students attending this intervention group tended to be more critical in their discussions of the selected sequences, which corroborates recent findings about teachers' analyses of other teachers' videos (Kleinknecht & Schneider, 2013). Nonetheless, also in this setting premature or generalizing judgments about the teaching in the video could be counteracted by means of questions that tightly focused on the actually observed or assumed effects of the teachers' instructional behavior and through persistent requests for a rationale for proposed improvements. Furthermore, other teachers' videos proved to be especially suited for reflections on the organization of instructional processes, which allowed the students to get new inputs for their own practice. Exactly this very aspect, however, could be the reason why the students' competency development was rated slightly lower. A facilitator put it as follows:

> All examples of actual teaching practice are good examples. So they provide the 'right way of doing it' from the very start, and give little scope for critically dealing with classroom reality which, every now and then, involves difficult situations too. Had the students been confronted with 'bad' examples of teaching, they would have had to think more actively themselves about the point of good teaching and about what is important to do, or also, about what the 'typical' mistakes really consist in. This would have required an occasional change of perspective, which would make much sense to me.

Moreover, this quote implicitly proves that videos of other teachers were perceived as positive examples, which was not the original intention of the research team. As for the preparation of the analyses, the facilitators who had worked with other teachers' videos appreciated the research team's precise instructions as to which course contents and basic features of effective teaching could be analyzed in the preselected videos.

In comparison with the video settings, case-based learning with *written examples of actual teaching practice* received about equally high student ratings in terms of acceptance and effectiveness. And again, the facilitators assessed the written teaching materials as a useful means for considering different aspects of lesson planning and teaching. As in the intervention setting with other teachers' videos, they got the impression that they had not always been sufficiently able to attend to the students' interests and questions, which had apparently been easier in the groups who had worked with their own videos.

As regards the *Lesson Analysis Framework (LAF)*, the facilitators from all intervention groups found its guidelines for structuring the discussions very helpful, and the systematic procedure was thought to further constructive explorations of the teaching sequences under consideration. While moderating the joint analysis of the examples of actual teaching practice, the facilitators were careful to make sure that the process kept to the fixed order of the single analytical steps, and to prevent hasty judgments about the observed teaching-learning situations. Besides, they repeatedly had to remind the students to substantiate their comments in terms of their relevance to the pupils' learning and by making reference to theoretical considerations. Unless such rationales had explicitly been asked for, the students manifested only little drive to propose reasons themselves. From a more general point of view, one of the facilitators summarized the challenges of case-based learning as follows:

> The students are strongly oriented towards learning a lot of practical techniques for teaching in the classroom, but they do not like it very much to question things and to analyze them, and they provide only very few theoretically substantiated reasons themselves. They deem it sufficient, so to speak, to hear that something works more or less well. The question of how pupils learn and think plays a comparatively minor role. Such attitudes are difficult to change.

Another facilitator got the following, somewhat more balanced impression: "Some of the students found the reasoning processes very tiring (and accordingly demotivating), whereas others stated that they had benefited quite a lot from them."

5 Conclusion

Assessments of case-based learning with examples of actual teaching practice obtained from pre-service teachers and their facilitators indicate that this method is appropriate already at the very beginning of the initial teacher education. As far as the comparison between the two types of video is concerned, our results show that especially working with one's own videos meets with a high degree of acceptance, and that its effectiveness tends to receive somewhat higher ratings than working with videos of other teachers. In sum, both video-supported ways of case-based learning are accepted and can be applied in an effective manner, particularly if the specific benefits and challenges of working with videos are clearly kept in mind.

Further analyses will have to establish whether also the students' professional vision – which was measured by means of the standardized video-based instrument *Observer* (Seidel & Stürmer, 2014) – has improved in the three different intervention settings. As first findings indicate, the increase in the video groups is significantly higher than the increase in the control group with teaching and learning materials (Krammer et al., 2013).

Furthermore, our analyses confirm the assumption that questions (like those, presented in section *Procedure of the video analysis: LAF*), which direct the focus of attention to the pupils' learning processes, are essential to the development of professional competence (Borko et al., 2008; Santagata & Guarino, 2011; van Es et al., 2014). Supplementary materials (in particular work outcomes of the pupils) can perform an extra supportive function, because they render the effects of the teaching activities on the learning processes better observable.

As regards a permanent implementation of case-based learning with videos in teacher preparation programs, some of the participating facilitators argue for a combination of working with the students' own and working with other teachers' videos. For introductory purposes, most of them favor starting off with sequences from other teachers' classrooms, and thereafter turning to the students' own videos. Current findings indicate that this combination is an efficient method to improve professional vision in teacher education (Hellermann et al., 2015). As an indispensable precondition for successful and productive learning with videos the facilitators' open comments generally emphasize a careful introduction as well as mutual confidence building, which prepares the ground for appreciative discourse. Besides, also a well-considered selection of suitable video sequences together with supportive supplementary materials and adapted assignments are thought to be crucial. Another aspect which should equally be taken into account is that video-based reflection on teaching is quite time-consuming, if it is to go in depth. Yet it is not only the actual group work in class itself that is very demanding. As several comments explicitly note, the facilitators necessarily need to pre-analyze the selected video sequences for themselves and establish the links with the pertinent theoretical knowledge about effective teaching beforehand. Still, such careful and thorough preparation activities are considered indispensable, if the discussions with the students are to be fruitful and substantial.

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Kathrin Krammer
University of Teacher Education Lucerne
Pfistergasse 20, Postfach 7660, 6000 Lucerne 7, Switzerland
kathrin.krammer@phlu.ch

Isabelle Hugener
University of Teacher Education Lucerne
Museggstrasse 37, 6004 Lucerne
isabelle.hugener@phlu.ch

Manuela Frommelt
University of Teacher Education Lucerne
Töpferstrasse 10, 6004 Lucerne
manuela.frommelt@phlu.ch

Gabriela Fürrer Auf der Maur
University of Teacher Education Lucerne
Museggstrasse 37, 6004 Lucerne
gabriela.fuerrer@phlu.ch

Sandro Biaggi
Zurich University of Teacher Education
Lagerstrasse 2, 8090 Zürich
sandro.biaggi@phzh.ch

Video-based Reflection on Teaching: What Makes It Effective?

Niels Brouwer

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Since the beginning of the new millennium, the use of digital video for teacher education and professional development (PD) has grown into a burgeoning and exciting field of research and development (R&D). The collection of empirical studies in this special issue clearly exemplifies this trend. I will begin this comment by pointing out the societal relevance of developments in this field. Then I will discuss the nature of the findings of the six studies and their implications for the design of video interventions as well as for theory and research.

The promise of visual teacher learning for fostering higher-order learning and teaching

The promise of video use in teacher education and PD lies in its potential to encourage a transfer between practice and theory. This potential can be attributed to a number of unique features of the medium. Because of its vividness, video can focus teachers' attention on the complex interactions between the content of learning, their learners' (re)actions and their own. The age-old metaphor of the "instructional triangle" retains its power. The concreteness of video images invites teachers to make the analysis of teaching and learning subject-specific. The user-friendliness of digital video enables repeated analysis from different perspectives without the need for immediate action. And last but not least, moving images invoke vicarious experience (Laurillard, 1993, p. 114) and emotional response. Together, these features can encourage teachers to connect intuitive and rational modes of thinking about their work or "thinking fast and slow", as Kahneman has aptly termed them (2011).

Recent reviews of the research into video use for teacher development have yielded indications that it can help teachers change their classroom behaviour (Gaudin & Chaliès, 2015, pp. 54–55) and specifically so in the direction of forms of teaching that are suitable for fostering higher-order learning. The nature of change in teachers' action after participating in what I call Visual Teacher Learning (VTL) has to do with firstly taking more initiative and a more activating role in the classroom. Teachers achieve this by acquiring, developing and/or sustaining basic teaching skills, by talking less oneself while simultaneously encouraging learners more to engage with and talk about the lesson content by using more open and probing questioning. These behaviour changes in teachers result in more on-task behaviour in learners on higher levels of cognitive activation. A second effect of video-enhanced reflection on their work is that teachers give their learners more feedback with more focus. Thirdly, during classroom teaching they act and react more adaptively. Finally, video-enhanced reflection encourages teachers to target and try out effective teaching behaviours (Brouwer, 2014, pp. 183–187).

I think these review findings are extraordinarily relevant for any efforts to raise the quality of instruction throughout education. Quality of instruction is a key factor influencing the contribution a country's education system can make to its economic prosperity and cultural vitality (cf. OECD, 2005; Hattie, 2009). In this area, teacher education and PD have a multiplier function to fulfil. The greatest challenge currently facing them is to promote the shift from teacher-dominated and reproduction-oriented learning towards active, higher-order learning, in which pupils develop an understanding of foundational, transferable concepts. Such higher-order learning is increasingly being demanded by technological developments in industrialised as well as industrialising countries.

Overview of studies

The studies in this special issue show a similar diversity as found in most studies of visual teacher learning in the past fifteen years. They address both preservice and in-service applications. The duration of the interventions studied varies greatly, between weeks and one year. The number of teachers involved ranges widely, between one and 169. Some studies include control groups, others do not, i.e. four and two studies respectively.

The six studies also pertain to a multitude of factors influencing teacher learning. This is inevitable and desirable, as their objects of study are specific interventions in the real world of teaching and learning. Such relevant factors are:

a. in which *career stage* participants find themselves: preservice, beginning or experienced;
b. who is being viewed in the videos shown: the teacher him- or herself and/or colleagues (*self- vs. other-viewing*);
c. what *type of video* is used in the intervention: "action videos" showing everyday teaching, "model videos" intended to demonstrate exemplary teacher behaviour, "trigger videos" intended to elicit cognitive friction in and debate among viewers (cf. Fortkamp & Van den Berg, 2005) or no video, as in comparisons with written teaching cases;
d. how much and what kind of *structure* facilitators introduce into teachers' analysis and interpretation of video recordings;
e. from which source(s) teachers receive *feedback*: peers, experts and/or learners.

It is an important task for researchers to disentangle and evaluate the relative contribution that each of these factors may make towards effects on teachers' professional learning. In this respect, primary studies such as in this theme issue provide the foundation for review studies.

What is characteristic of both the studies in this issue and the wider literature is that the dependent or criterion variables pertain more often to teacher perceptions and thinking than to (changes in) teacher behaviour and (its impact on) outcomes in learners (cf. in this issue: Minaříková et al., 2015; Vondrová & Žalská, 2015; Mohr & Santagata, 2015; and Krammer et al., 2015).

Finally, both quantitative, qualitative and mixed-methods studies are reported. Quantitative studies are strong in demonstrating the impact of interventions on teacher thinking and/or behaviour. Qualitative studies are strong in revealing the complex causation involved in VTL, i.e. clarifying the interplay of conditions and processes in how effects on teachers and learners come about.

What is also characteristic and encouraging at the same time is that the findings of most studies confirm that using video for teacher education and PD is more effective than not using video. This confirms what Elizabeth van Es once said: "We know that it works. Now we should know how and why."

Implications for intervention design

The findings of the studies in this special issue lend support to the critical features of effective PD interventions for teachers as explicated by Desimone: coherence with teachers' knowledge and beliefs, daily practice and school, district and state policies; content focus; active learning; duration and collective participation (Desimone, 2009; cf. Guskey, 1986, 2000; Borko et al. 2010; Van Veen et al., 2012). At the same time, the study findings suggest possible specifications and elaborations. In this regard, I would like to make the following remarks.

All studies confirm the need for *subject-specificity* of assignments and formats for the analysis and interpretation of video records of classroom teaching. For the design of effective VTL interventions this means that a productive line of work is to explicate on the basis of valid theory and research catalogues of effective teaching behaviours, not only on a generic level, but also specific to different school subjects. Such catalogues may be operationalised in the form of viewing guides that teachers can use to guide their professional learning (cf. Brouwer, 2011).

When comparing studies of VTL interventions it appears to me that their effectiveness may depend not only on the presence or absence of the critical features mentioned above, but also or even more on *how they are combined* in a specific intervention. Two exemplary large-scale studies (Kersting et al., 2012; Roth et al., 2011) have shown that carefully implemented video-based interventions can help teachers change their actions in the classroom in ways that demonstrably improve pupil achievement. For this to occur, apparently a host of necessary conditions needed to be fulfilled simultaneously, i.e. teachers received material support from school leaders and modelling from facilitators *and* participated in coaching activities in an atmosphere of community and trust *and* engaged in collaborative lesson planning *and* purposefully enacted over a prolonged period step-by-step changes in their classroom work. A similar conclusion can be drawn from another large-scale study including effects on pupil learning (Matsumura et al., 2013). This evaluation of a coaching intervention – without video – indicates that fidelity of implementation is an influential precondition for effectiveness.

From this perspective, it is interesting to see – most clearly in the interventions studied by Schindler et al. (cf. Pehmer et al., 2015; Schindler et al., 2015) and Berson et al. (2015) – that the challenge to teachers of translating thought into action crucially depended on opportunities to repeatedly collaborate on lesson planning and move rapidly through complete cycles of planning, teaching and reflection. This finding suggests the importance of designing PD activities as *consecutive cycles*. Different choices are possible here. Korthagen's ALACT model (Korthagen et al., 2001) emphasises retrospective reflection, often focusing on generic aspects of teacher behaviour. Central to Santagata's *Lesson Analysis Framework* (Santagata & Guarino, 2011) is the retrospective analysis of subject-specific student learning. The strategy of *content-focused coaching* introduced by West & Staub (2003) on the other hand, emphasises prospective reflection focusing on subject-specific learning. The *Problem-solving Cycle* developed by Borko et al. (2008) as used by Berson et al. and adapted as the *Dialogic Video Cycle* by Schindler et al. involve balancing prospective and retrospective reflection focusing on subject-specific aspects. I think it would be well worth the investment to consider – both in intervention design and in empirical evaluation – what consequences such different choices may have for teacher and pupil learning.

A recurring issue is what is more effective, other- or self-viewing (cf. Kleinknecht & Schneider, 2013). No clear-cut evidence of superiority of one over the other seems to emerge. From the study by Krammer et al., it rather appears that they have different merits. In particular, their qualitative findings suggest that other-viewing can foremost encourage teachers to recognise, name and elaborate on effective teaching practices, while self-viewing tends to foster foremost analysing one's own local teaching practice critically.

Implications for theory and research

Above, I already noted that explicating catalogues of effective teaching behaviours for different school subjects would be a fruitful endeavour in order to raise the effectiveness of video-enhanced reflection on teaching. Underpinning viewing guides or other forms of operationalisation with valid theory and research about subject-matter content and pedagogy is, I think, a necessary foundation for the drive towards higher-order learning. This requires enduring investments in educational R&D work, not only in science, technology, engineering and mathematics (STEM), but in all school subjects. There is also a risk here. The literature about pedagogical content knowledge (PCK) contains instances of semantic tournaments characterised by little parsimony and even less practical relevance. What we need, rather, are concise and concrete descriptions of effective teaching behaviour, whose usability and merit for teachers is demonstrated by research.

The studies by Schindler et al. and Berson et al. illustrate the merits of research covering the *whole causal chain* of events from the design and implementation of VTL interventions through their effects on teacher thought and action to impact on pupils' learning processes and achievement. As noted, most VTL research until now takes teacher perception and thought as its end point, often under the heading of "professional vision". However, I think we should extend our operationalisations beyond teachers' perception and thinking to include their interaction with learners, its nature, its impact on pupil achievement as well as how its effectiveness can be enhanced.

Concluding remarks

Moving research into visual teacher learning in this direction requires a specific methodology. It is already quite productive that quantitative studies demonstrating outcomes and effects of interventions coexist with qualitative studies exploring how learning effects come about. Empirical knowledge about processes and conditions is indispensable for underpinning the design of effective interventions. The studies by Krammer et al. and Schindler et al. illustrate the merit of conducting mixed-methods studies, i.e. strategically combining qualitative and quantitative methods within one study or project. A causal-genetic research paradigm using mixed methods (cf. Brouwer, 2010) holds promise for scientific explanation and as such for designing interventions which demonstrably benefit the work of teachers.

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Niels Brouwer
Radboud University, Nijmegen, Netherlands
n.brouwer@docentenacademie.ru.nl

A Truly Constructivist Conference on Constructivism[1]

Stanislav Štěpáník

With no doubt, constructivism is one of the leading streams of innovation in education today. However, there are not as many constructivist conferences and meetings as we would expect or wish for. One of the regular events in this regard is the annual conference of the American Association for Constructivist Teaching (ACT). This year constructivist teachers, educators and enthusiasts from all over the United States (with a few international guests) gathered in Charleston, SC on 5th to 6th December to discuss research, theory, and practice of constructivism; constructivist teaching practices, their perspectives and possible implementations of constructivism into the educational process under current policies and developments in education.

This year's dominating topic was the American Common Core standards that define what students in all grades must learn in English and math, and that have brought controversy into the debate about education in the US. The proponents of the plan say that it moved away from gaps created by the No Child Left Behind Act of 2002, which, among other requirements, wanted students in all states participate in annual testing. On the other hand, the opponents say that it has stripped teachers of the possibility to use alternative methods and forms of work and also tightened up the content without any possibility of enrichment – as Marion Brady, a teacher, wrote, the Common Core kills innovation and standardizes not only the content the students are taught but also their minds and the way they think, which is "about as far out of sync with deep-seated American values as it's possible to get"[2]. Therefore a great part of the discussions among participants at the conference was the position of constructivism within the Common Core. Mostly they have agreed that the standards have made it more difficult for teachers to apply any kind of alternative approaches, including constructivism.

Despite the fact that the current situation is not favourably inclined to implementation of constructivism in schools, the participants of the conference agreed that it is necessary to continue in the effort as they expressed a clear conviction that constructivism is the way the educational innovations should be going as it respects the mind-set and natural thinking processes of a child. Moreover, it gives the learners

1 The report has been supported by the grant project UNCE 204001/2012 Centrum výzkumu základního vzdělávání [Centre for basic education research].

2 http://www.washingtonpost.com/blogs/answer-sheet/post/eight-problems-with-common-core-standards/2012/08/21/821b300a-e4e7-11e1-8f62-58260e3940a0_blog.html. [cit. 2014-12-08].

 autonomy and responsibility for their learning, which brings higher motivation than in the traditional school setting.

Before the conference, the participants had the opportunity to visit two schools, one elementary school with a beginning IB program, and one kindergarten which uses a very open-to-nature approach. Certain constructivist practices could be observed.

As we would expect, a conference on constructivism is not a typical one. The sessions are not 15-minute presentations in the form of a monologue delivered by the presenter, but they are 60-minute workshops where the audience is actively involved either in a directed dialogue or discussion or even practical activities. The presenters are therefore asked to adapt a real hands-on approach as the theory of constructivism prescribes. Speakers from universities, colleges and lower schools – from university professors to elementary school teachers – from all over the United States and also abroad presented their papers on theory and practice of constructivism in education.

Among these workshops, there were also keynote sessions. The first keynote speaker Dr. Gloria Boutte from the University of South Carolina introduced the areas of Critical Race Theory, African American Emancipatory Pedagogy and Culturally Relevant Pedagogy, and stressed the necessity for schools to create environments that would support pupils with diverse racial, social and gender identities. She primarily focused on pupils from various ethnic backgrounds, especially looking at the problem of Afro-American children in current US schools and in the current US school system. Especially with regards to the topical events in the United States (the last several cases of police violence towards Afro-Americans), this is a strong message.

The second speaker Dr. Satomi Izumi-Taylor from the University of Memphis spoke about education and its perception in Japan. While early childhood education in Japan is greatly supported and it is an open space for innovations, secondary education stays rather on the edge of interest, and is dominantly being looked at from the point of view of factual knowledge rather than developing skills or students' personalities. This, of course, leads to a very traditional and competitive teaching approach at secondary schools.

The special guest at the conference was Dr. Constance Kamii, Professor at the Department of Curriculum and Instruction at the University of Alabama at Birmingham, and Piaget's student in Geneva. The ACT decided to award her for her long-life excellent work which has influenced mathematics education in the United States, including the national curriculum. In her talk she stressed (as already many times) that the traditional methods of teaching in Grades 1 to 4 are harmful, and "make pupils stupid" as they tell pupils to give up their own thinking. "We're paying tax dollars to make our children stupid!" she exclaimed. She also demonstrated several constructivist approaches, and warned the audience not to wait for her maths textbook for the 4th grade as she said she was not able to finish it because parents teach their children the traditional algorithms and by doing so destroy their children's mathematical thinking.

The overall message of the conference was the one that has been mentioned in many of the participants' conversations, and was voiced at a session given by tutors and their students, future teachers, from Ferrum College from Ferrum, VA. In reaction to the enthusiasm for innovation and constructivism of the teachers-to-be, one of the speakers from the audience warned them that in about four years they would become the same traditional teachers who they at that time did not want to be if they did not have the courage to speak up. "You must have the courage, the voice, the arguments. For the parents, the principal, the school board, the authorities. The arguments on why you are doing things the way you are doing them. Why you are approaching things differently. Because if you don't know why you're doing it that way, the old traditionalists will always get you." It is self-evident that these strong words were rewarded by applause, and were further discussed long after the session finished.

Stanislav Štěpáník
Czech Language Department
Faculty of Education
Charles University in Prague
stanislav.stepanik@pedf.cuni.cz

School Tracking: Diverse Mechanisms, Effects, and Policy Responses Conference Report

Vít Šťastný, Monika Boušková

An international conference *School tracking: Diverse mechanisms, effects and policy responses*[1] was hosted by the Faculty of Education of Charles University in Prague in the warm days of 26th and 27th May 2015. The central topic of the conference, as its title suggests, was *school tracking*, which refers to the practice of assigning students to instruction groups on the basis of their ability (Hallinnan, 1994). As the conference moderator David Greger suggested at the beginning, the issue of tracking, its mechanisms, effects, implications for equity in education, and adequate policy responses was a hot topic in the USA in the 80s. The debate about tracking in the USA may not seem so lively nowadays but the issue is being widely discussed on our continent, especially in central Europe. The conference was organised by the Institute for Research and Development of Education, for which the topic of school tracking is in the long-term research focus. One of its current research projects is the Czech Longitudinal Study in Education (CLoSE), which aims, besides other goals, at researching the effects of tracking on chosen cohorts of Czech pupils. It is charting their passage through the Czech education system in the long-term. The organisation of the conference was supported by this research project in cooperation with the National Training Fund and CERGE Economic Institute.

After the opening ceremony, in which the dean of the Faculty of Education Radka Wildová welcomed all participants, the floor was taken by the keynote speaker *Adam Gamoran*, a recognized and respected scholar in the field and at the same time, a member of National Board for Education Sciences[2] appointed by president Obama. His introductory speech *Tracking, De-tracking and Student Achievement: Is there a better way?* framed the whole conference topic. Dr. Gamoran provided a broad overview of current issues and pitfalls connected with tracking and also illustrated possible system changes based on several examples from various countries. Although it may seem logical and effective to track students or pupils according to their abilities, Gamoran says tracking could possibly lead to their separation according to race or social class; homogenous classes lack the diversity that may foster rich discussions. In addition, the inequalities between tracks rise over time. There are,

1 The conference was supported by GA ČR (National Science Foundation) within a project "The relationships between skills, schooling and labor market outcomes: A longitudinal study" (No. P402/12/G130).

2 The National Board for Education Sciences is an advisory body of the Director of Institute of Education Sciences (research arm of the U.S. Department of Education).

according to Gamoran, two possible responses of the educational stakeholders. The first is to reduce the tracking, but at the same time provide challenging instruction to high achievers. The second consists of maintaining tracking but providing a more effective instruction in low tracks. The current research develops promising new directions in both ways, as Gamoran demonstrated on various examples. In the Czech context, where the public opinion is essentially in favour of maintaining the current early selective nature of education system (Walterová et. al., 2010), the second option (the implementation of high standards for low-achieving students) may seem more likely to be accepted.

Other contributions presented at the conference introduced the results of authors' own empirical research on the given topic. This thematically rather narrow and in terms of number of active participants smaller conference with no parallel sections was attended not only by local specialists, but also guests from the United States, Germany, Belgium, and Slovakia, that is from countries with structurally diverse education systems with various level of selectivity and early tracking. This fact echoed in subsequent discussions and turned out to be very beneficial and inspiring for sharing experience and implicit comparisons of the local situation and situation abroad. Presenters could benefit from a high-quality feedback from discussants and other conference participants. Papers[3] presented on the first day of the conference were all focused on tracking at the lower-secondary level of education system, whilst the second day of the conference was dedicated rather to tracking at higher levels of education system.

Local policy players may have a significant role in influencing the public opinion towards later school tracking. Bearing this in mind, *Marcela Veselková* from Komenský University in Bratislava analysed how macro-level political narratives of less selective schooling (produced and advocated e.g. by OECD or UNESCO) influenced the political communication of Czech and Slovak educational stakeholders. Deeper analyses of non-cognitive outcomes of tracking are still scarce in the Czech Republic. *David Greger* from the Institute for Research and Development of Education endeavoured to fill this knowledge gap. He focused on the analysis of pupils' academic self-concepts, which are formed not only by their individual academic performance, but also by the average performance of their peers in the classroom or the school. In literature, this is referred to as the Big Fish Little Pond Effect. Based on the analysis of PISA and TIMSS data, Greger confirmed the validity of BFLPE model in the Czech Republic, nevertheless many questions still remain, and Greger pointed out also his future research directions. Germany is a well-known example of a country with highly selective education system tracking pupils directly after primary school. *David Becker* from Deutsches Institut für Internationale Pädagogische Forschung provided an insight into Berlin de-tracking reform, in which previous multiple tracks were reduced to the two-path system with academic (Gymnasium) and non-academic (Integrierte Sekundarschule) tracks. He evaluated the reform influence on parental

[3] Selected presentations are available at the conference website http://pages.pedf.cuni.cz/uvrv/schooltrackingconference2015/ for download.

aspirations, teacher recommendations and transition of pupils into tracks with regard to their socio-economic status. First day was then concluded by *Lore van Praag* from Gent University who focused on the pupils' self-appraisal and its determination by the track pupils are in.

The second day of the conference, *Hana Voňková* demonstrated the anchoring vignette method in a quantitative survey of ICT knowledge and skills among students based on self-reporting. The responses may reflect not only the actual level of knowledge and skills but also the self-assessment style. Two students with the same level of actual knowledge and skills level may give different self-assessments but the anchoring vignette method helps to adjust self-reports' differences in scale usage. *Filip Pertold* from CERGE-EI (Centre for Economic Research and Graduate Education-Economics Institute) investigated the problem with peers' pre-secondary-school smoking, as the empirical findings based on data from Czech Republic reveal a high level of youth smoking. The research results show that male youth smoking is significantly affected by classmates, while female youth smoking is not. The following presenter was *David Münich* also from CERGE-EI institute with presentation of *Inefficient School Matching Mechanisms: The Case of the Czech Republic*. At first he described the model of entrance examinations at high schools in the Czech Republic. According to Münich's opinion, different models of entrance exams promote unequal opportunities for students with worse socioeconomic status. The fourth presenter, *Jana Straková,* focused on the current issue of apprenticeship education in the Czech Republic and its relation to the labour market demand. Straková dealt with the length of apprenticeship study and highlighted the question whether or not students acquire sufficient knowledge and practical skills for the labour market. Another problem is that education system allocates students into academic, vocational and apprenticeship tracks that provide different quality of knowledge and skills. Data analysis pointed out that apprentice students tend to acquire lower general skills compared to academic or vocational students. In conclusion, the question is how to deal with unequal education requirements in different tracks. The last contribution, *Evaluation of Detracking Reforms in the USA and Their Transfer into the Czech Education System,* was presented by *Markéta Holubová*. In the first part she described the detracking of US education system at elementary schools (ISCED level 1 and 2). The analysis emphasized the marginal correlation between family's socioeconomic status and place of residence. Holubová confirmed that education in the United States does not support early selection unlike Czech education system. In conclusion, in both countries (USA and CZ) students from ethnic minorities are overrepresented in low tracks. This contribution closed the official part of the conference. An unofficial part of the conference continued with a commented city walk tour through the centre of Prague.

Methodologically very diverse papers were based on content analysis of documents (Veselková), secondary analysis of large-scale research data (Greger, Straková, Pertold), own quantitative survey (Becker, Voňková), qualitative ethnographic study (Van Praag) or in-depth interviews (Holubová). This list documents wide possibilities of research approaches towards tracking, and although the conference was oriented rather on factual matters, methodological aspects and critical evaluation of the employed methodology were often stressed in consequent discussions.

On the third day, *Adam Gamoran's* presentation *Inequality is a problem: What is our response?* was held at the American centre in Prague. The presentation reflected the significant issue of increasing differences among the outcomes of children in the USA. Adam Gamoran suggested approaches to improving quality of education system through health care programs, high quality early childhood programs, family-school cooperation programs and socio-psychological interventions.

*To conclude, t*he conference contained many interesting presentations covering a wide range of theoretical and empirical perspectives focused on sorting students into different tracks. As conference participants, we agreed that the topic of tracking is still not discussed enough by the public, therefore more effort should be made to disseminate the research findings in this field. We consider the lecture of a recognized researcher that was available for free to a wider public at the end of the conference a good start.

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Vít Šťastný
Charles University in Prague, Faculty of Education, Institute for Research and Development of Education
vit.stastny@pedf.cuni.cz

Monika Boušková
Charles University in Prague, Faculty of Education, Institute for Research and Development of Education
monika.bouskova@pedf.cuni.cz